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BASIC UNDERSTANDINGS NECESSARY FOR THE PLANNING
AND INSTALLATION OF ELECTRONIC DATA
PROCESSING SYSTEMS

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CHAPTER I

INTRODUCTION

General Statement

The vast increase in the use of computers has created a demand for the assistance of accountants in the planning and installation of electronic data processing systems. Therefore, the accountant must extend his theoretical accounting knowledge to the realms of electronic data processing (EDP), even though his present establishment may not warrant extensive EDP knowledge in order to be prepared for the possibility of future installation on his present job or by a client. The controller should be especially concerned with becoming knowledgeable about electronic data processing because historically, he has been responsible for introducing and operating large scale mechanized systems.

Purpose

The purpose of this study is to discuss the basic problems involved in planning the installation of an electronic data processing system in the controller's division. However, these problems are basic to all installations. The

controller's division was selected because historically, the introduction and major use of mechanized systems has been in the accounting area. Although particular areas of interest to the accountant such as the EDP bookkeeping system and auditing will be discussed, the key steps of planning an electronic data processing installation should be of interest to any individual concerned with the project. Therefore, the basic problems will be emphasized because the author feels that these problems encompass those of most facets of EDP that the accountant will encounter even if not on this level, because he may render services in terms of accounting and auditing, tax, administrative services, et cetera. For the purpose of this study, the roles of the accountant are: (1) the controller who directs the EDP planning committee which is to plan the initial installation of an EDP system in the controller's division, (2) the auditor who suggests and approves the audit techniques used to control and evaluate the system, and (3) the consultant who examines and checks plans before they are implemented, whereby, the realms of accounting extends to management services. Although the installation is within a private enterprise, reference will be made to Certified Public Accountants because the auditor and consultant are external accountants; whereas, the controller is

an internal accountant. The "accountant" refers to the basic professional status of the controller, auditor and consultant.

In addition to the basic problem involved in planning an EDP installation, the following seven key steps in planning and related problems will be discussed:

1. Identify Problems
2. Select Objectives
3. Determine Requirements
4. Design System
5. Select Equipment
6. Determine Economics
7. Evaluate Feasibility

Procedures for Study

Sources of obtaining information for this study were:

(1) books of management information systems, accounting and basic electronic data processing; (2) bulletins and journals of accounting and automation; (3) accounting associations; (4) accountants--private and public; (5) programming and system personnel; and (6) computer manufacturers.

Methods of data collection used were review of related literature, textbook presentations of information on

problems involved in planning the installation of an EDP system, and articles were selected from bulletins, journals and reviews such as the Journal of Accountancy, Accounting Review, National Association of Accountants Bulletin, Harvard Business Review, Computers and Automation, et cetera.

Correspondence was the means for collecting specific information from organizations which had a relationship with accountants faced with the problems of computer installation. Specific organizations were Arthur Andersen and Company, Incorporated, The American Institute of Certified Public Accountants, The American Management Association, and The National Association of Accountants. International Business Machines Corporation, Honeywell Electronic Data Processing Division, and The National Cash Register Company were also included because of their rating in the AICPA Computer Survey Results and their popularity as indicated by purchases of accounting firms and industry.

Interviews were another major source of information. The interviews were conducted both formally and informally with accountants and programming and systems personnel. The following persons were interviewed: Accountants Donald Dixon and Gordon Hamrick, and Jim Watts--Consultant for Computer Installations of Arthur Andersen and Company,

Atlanta, Georgia; Consultant-Programmer Donald P. Kahn of Philip C. Pipher Associates, Incorporated, Washington, D. C.; Assistant Controller L. A. Davis of Pittsburgh Plate Glass Company, Pittsburgh, Pennsylvania; Controller Division Manager F. M. Burns, Business Analysis Section Manager W. F. Ward and Departmental Accounting Manager V. C. Dyer of DuPont, Wilmington, Delaware; Systems Analyst Jim Dewindt of The First National City Bank of New York, New York; and Chief Accountant H. V. Ryan, Data Processing Manager J. Milano and Corporate Systems Manager H. B. Wheeler of Charles Pfizer, Incorporated, New York, New York.

Definition of Terms

A selected glossary of technical terms and electronic data processing (EDP) terminology with which an accountant should be familiar to the extent of using them in communicating intelligently with programming and systems personnel or to understand the basic EDP literature, is presented at the end of the last chapter. However, technical terms and electronic data processing terminology are defined throughout the presentation.

Accounting and the Functions of
the Controller

Accounting.--Accounting is an activity and an approach to managing a business which is carried on throughout the business in terms of sales analysis, financial management and production planning. However, the department of the controller's division which bears the name "accounting" is the focal point for analysis and reporting of business information in financial terms.¹ In this department is the accountant who by the nature of his profession has an obligation to the firm and business community as a whole to promote the practice of generally accepted accounting methods and to improve the standards of record keeping and reporting.

Throughout the entire evolution of the accounting process, the trend has been toward the elimination of time spent on manual operations. This time has always been a major component in the cost of producing financial information. With the increasing complexity of modern business, the volume of documents to be handled has increased astronomically. Additional complications result from modern tax and management which are such that the average and small

¹Gardner M. Jones, Electronics in Business (East Lansing: Board of Agriculture of the State of Michigan, 1958), pp. 1-2.

businessmen are relying on the accountant to provide him with professional advice and assistance in evaluating statements and reports.¹

The functions of the controller.--The controller is more than an accountant. The controller is responsible for the design and operation of the system by means of which information for determining whether the organization is conforming to the plans and policies of management is collected and reported. He may also be responsible for the collection and analysis of figures, pointing out their significance to management, and for making recommendations as to the appropriate action. In addition, he controls the integrity of the accounting and is responsible for safeguarding assets from theft and fraud. Although he has these tremendous responsibilities, the actual use of control information is by line management; the controller is a staff officer.²

The Impact of Automation on the Accounting
Functions of the Controller

As business became more complexed, the need arose

¹Lee J. Adamson, Byron E. Haglund, and Richard D. Metcalf, Accountants' Data Processing Services (New York: The Ronald Press Company, 1964), p. 4.

²Robert N. Anthony, Management Accounting Principles (Homewood: Richard D. Irwin, Inc., 1965), pp. 259-260.

for improved accounting systems and procedures because information is useful to the controller as a means of communication. That is, accounting reports are the controller's means of informing the organization about management's plans, policies and types of action that management wishes the organization to take. This tremendous responsibility of the controller presented the problem of developing some accounting procedures that required only a simple level of accounting competence at the source of accounting data, followed by the efficient processing of such data for recording compilation and preparation of reports with a high degree of professional know-how for interpretation of the derived data.¹

A combination of these features is now possible. It can be implemented with the use of electronic data processing units with the controller acting as a catalyst between the simple recording techniques necessary at the source of the original data and the speed and technical accuracy in recording and compiling data in a form required for evaluation by management. In addition, he maintains his advisory capacity and assists management in interpreting and evaluating the financial statements and reports. His EDP functions

¹Ibid.

may include: (1) designing a system that will allow the adequate preparation of source data by individuals with a relatively low level of technical training; (2) collecting source data, reviewing and modifying as necessary to place it in usable form for machine processing; (3) acting as an interpreter to translate the simple data source documents into sometimes technical language intelligible to electronic data processing equipment; (4) assisting the machine processing center in the solution of accounting problems that arise from time to time in the processing of source data; (5) assembling and presenting to the businessmen financial statements and reports produced by electronic data processing; and (6) furnishing technical advice and recommendations based on the results shown therein.¹

The electronic data processing units, by performing the mechanical details of processing accounting data and accounting functions of personnel with lower professional competence, frees the controller and his supervisory employees to do more productive and lucrative work.

In view of the techniques of journalizing, posting, drawing of trial balances and rough drafting financial statements, employees who have only basic accounting training may

¹Ibid., p. 7.

limit their activities to the review of source documents, checking for proper allocations to accounts and minor summarization.¹ The controller who is an internal accountant may economically undertake more creative projects because he is available for greater amounts of time, thereby being able to identify himself with the creation of profits as opposed to the mere reporting of historical data and the conservation of assets through tax savings. In this sense, the computer takes the drudgery out of the controller's existence, freeing him to realize his full potentials both in systems and procedures. Although the external accountant, auditor, for smaller firms or average private practice has not been affected to a great extent up to this point, it is essential also for him to realize the certainty of computers and automation in almost every phase of accounting and prepare to utilize this aid whenever the opportunity presents itself, or be prepared to accept the consequences as predicted by pessimists who see computerization as a creator of unemployment. However, computerization creates as well as eliminates jobs. It is an extension of human knowledge, not a substitute. Nevertheless, it can be readily understood that the computer could be considered a threat to the

¹Ibid.

accounting profession. First of all, an automated system generates more information, and faster than an accountant can manually prepare an analysis of his client's accounts. Secondly, the computer can automatically prepare balance sheets and income and expense statements supplemented with detailed listings. If banks and service bureaus were to continue to expand their electronic data processing services to the majority of all small and medium sized businesses without counteraction, accounting firms would be destroyed because these clients are the source of a substantial share of natural firms revenue.¹ On the other hand, if the computer is accepted as an aid, the accountant who is willing to become involved in systems work has at his disposal a tool with which to implement the integration of financial reporting and management services.

Although the physical components of the computer will be discussed thoroughly in a subsequent chapter, a brief description of the physical capabilities will be presented at this point as a partial substantiation of the opportunities that an accountant with a knowledge of systems

¹E. T. Boyle, "What the Computer Means to the Accounting Profession," The Journal of Accountancy (January, 1966).

has at his disposal.

Physically, the computer has a tremendous capacity to store information in its memory for subsequent recall. Examples of the elements that can be stored are price lists, cost factors, rates, descriptive data, equations, and sequential order of working with that data. In terms of speed, the computer will carry out programmed instructions and print out the results at beginning rates of 400 to 500 lines per minute. Once programmed, it can relate financial information in an infinite number of ways, far more effectively and with greater speed than the accountant; it can make calculations without the input of new cards or tape to activate new calculations.¹

In addition, computer systems permit the accountant to analyze sales separate and apart from other functions of the business without searching through files and original records. He can separate sales by employee, by geographical area, by department and by product. In regards to labor costs, it is possible for him to examine labor costs per hour, per unit, per classification of labor; analyze type as to whether it is seasonal, fixed, et cetera. The preceding

¹Ibid., pp. 42-43.

functions are but a few of the opportunities that the computer systems offer to the accountant who in the future will be able to obtain currently the basic data which are so necessary for management analyses.

Of more importance to the accountant than the speed and volume of information that the computer provides is the means it affords for carrying out more sophisticated, new and creative ideas in management services. He is able to record a financial transaction in its full environment for later retrieval by recording financial data with all the collateral information such as quantity types, descriptive material, et cetera.

Determining A Course of Action

The immediate concern is for the accountant to become knowledgeable of electronic data processing by increasing his skills in both capacities of the technology of the computer and in the area of advanced management techniques. The accountant may enter EDP on one of three levels: (1) reviewing the computer proposal, (2) performing computer feasibility studies, and (3) supervising computer installation projects.¹ The feasibility study would include an appraisal

¹Victor E. Millar, "The Three Levels of EDP," The Journal of Accountancy (February, 1967), 42.

of the economies, summary of other advantages, proposed installation schedule and equipment information, et cetera. Some aspects of installation are the basic concepts of systems design; evaluating both equipment and software; hiring, training, and supervising personnel; estimating time required for detailed design, programming, and conversion of a computer system; identifying the cost, savings and other advantages.

An accountant is likely to be chosen by management to work on one of these three levels because he has by virtue of his profession, the ability and responsibility to determine the effect of the proposed system on his audit program and to verify that the requirements for internal control and other basic accounting requirements has been satisfied. In addition, he is able to give management an independent evaluation, however, they are non-technical.

To maintain his present position of prominence in the business advisory areas, the accountant must become active in the development of computer systems. Boyle refers to accountants as business doctors and stresses the point of accountant involvement in EDP to show the extreme of his professional responsibility to his clients, himself and his staff. He qualifies the accountant, by virtues of his

profession, to be a main participant in the field which is due in part to his familiarity with accounting proofs and controls, with methods and systems, with business reporting, with costs, breakeven figures, pro formas, et cetera.¹

Boyle suggests that the accountant first improve his own skills through educational courses designed to train him in scientific techniques of solving problems.

¹Boyle, op. cit., p. 56.

CHAPTER II

THE BASIC PROBLEM

The basic problem involved in planning the installation of an electronic data processing system in the controller's division is for the controller who is working to the extent of his ability to take time from his regular duties to become acquainted with the computer, the electronic data process system of bookkeeping before he is actually involved with an installation or has to audit a system that has been computerized. This problem is being solved by accounting associations, electronic data processing organizations, computer manufacturers and firms by publishing articles in literature read by accountants and non-credit courses using closed-circuit television and lecturers on the job and at other times which are convenient for the accountant.

Elements of Electronic Data Processing (EDP)--Introduction to the Computer

The essential point about the computer is that it can carry out the fundamental accounting procedures. Once a computer has been programmed to perform a certain task such

as working out payrolls, it will do this work without further intervention on the accountant's part. This frees the accountants from the drudgery of monotonous or repetitious accounting operations. In addition, the tremendous speed of the computer enables the controller to carry out more detailed procedures. However, to use the computer effectively one has to think in detail about present procedures and problem solving.

A General Description of an Electronic Computer

Digital computer.--A major characteristic of the computer, which for the purposes of this study is the same as the modern digital computer, is its ability to cope with problems that are solvable by finite, discrete methods. That is, there are a definable limiting of steps and the data operated on is of a separate and distinct form of discrete sets of digits. A typical accounting problem would be the allocation of costs in a manufacturing process.

High-speed computations.--Another distinguishing feature of the computer is its capacity for high speed computations, although they are the simple basic arithmetic operations, which has made it possible to solve problems by performing millions of calculations in a second which would

have taken a group of accountants a life-time of labor on desk calculators. These calculations are performed by following a sequence of basic machine instructions, specifically arranged for a given task called a "program."¹

Stored-program.--The computer referred to in this study is the "general-purpose" computer which can be programmed to solve a wide range of problems as opposed to the "special purpose" computer which is designed with a fixed, built-in program to solve a specific type of problem with different sets of data such as computing payroll information. The instructions of a modern "general-purpose" digital computer are stored within the computer in the same form as its data. The stored instructions can be operated on by the computer just as the data can be changed and modified during the course of the actual execution, thereby characterizing the modern digital computer as an internally programmed or digital computer.²

The properties of a general-purpose computer.--A general-purpose computer can perform the following operations:

¹Donald Dimitry and Thomas Mott, Jr., Introduction to Fortran IV Programming (New York: Holt, Rinehart and Winston, Inc., 1966), p. 4.

²Ibid., p. 5.

1. Move information one place to another and find information already stored.
2. Perform basic arithmetic operations.
3. Make simple tests and decide which of two or more possible procedures to follow, basing such decisions on intermediate results, which may not be initially known.
4. Follow a prescribed sequence of operations.
5. Change the predetermined sequence of operations to be performed, depending upon the results of immediate operations.
6. Perform more complex operations by repetition of basic instructions and simple test, possibly modifying the instructions in the course of repeating them.
7. Store in the computer for later use, the results of the operations.¹

The Organization of the Electronic Data Processing Unit

The electronic data processing unit may be described as a "computerized system" that is the interaction of two or more programs and human actions to perform. The electronic data processor is composed of three distinct components: an input unit, the main computer, and an output unit.

Input/Output.--The input unit provides the main computer with all the instructions and data are needed to solve a problem by translating data and letters used in business into code systems within the computer system. The most common input devices are card readers and tape readers. In addition, direct communication with the computer is possible

¹Ibid.

by means of a console typewriter or control panel.¹ The output device translates the results of computer processing into an understandable form of legible, printed words or figures.

The media for input and output are punched cards, punched tape and magnetic tape. The most common medium for input is the punch card, a rectangular piece of card board which stores a given number of characters by representing them as holes in the card. This card is divided into eighty columns and twelve rows which provide twelve punching positions for each card. Ten of the twelve punching positions are numbered 0-9; two more punching positions are present but unnumbered between row 0 and the top of the card. Each column of the card is used to represent a digit--0-9, a letter--A-Z, or a special character--\$, #, +, et cetera.² The eighty columns are further divided into fields. A field is a number of card columns grouped together and treated as a unit.³ A key punch machine which has a keyboard similar

¹John Connelly and Robert M. Smith, "Computer Components and Concepts," Accounting and the Computer (New York: American Institute of Certified Public Accountants, 1966), p. 6.

²Dimitry, op. cit., p. 9.

³T. W. McRae, The Impact of Computers on Accounting (New York: John Wiley and Sons, Inc., 1964), p. 54.

to that of a typewriter is used to encode information into punch cards and flexowriters are used to prepare paper tapes.¹

Paper tape is similar to punch cards, however, its use is not common because it is a continuous form which is somewhat cumbersome when locating and correcting errors. Another continuous form is the magnetic tape which is a long strip of plastic material coated with a metallic substance which is capable of storing characters coded in the form of magnetic spots. A character of information is represented by small magnetized sections of the channels located vertically across the width of the tape.²

The main computer.--The machine which is the central part of the computer system is composed of three sections: control, arithmetic, and memory. The control section has two main functions: (1) obtain instructions from storage in the established time sequence, and (2) activate the necessary control mechanism for the proper execution of each instruction. The instructions which are stored in the computer's memory give the computer directions for processing data and

¹Dimitry, op. cit., p. 9.

²McRae, op. cit., p. 55.

determine the specific data to be sent to and from memory and/or to and from the arithmetic section. The arithmetic section, "logic unit," composed of circuits, transistors and wiring performs fundamental arithmetic operations and a variety of logical operations such as comparing numbers, testing signs, shifting digits within arithmetic registers and forming logical products. The computer's memory section stores the initial data, the program of instructions, immediate and final results before output and any other information pertinent to the solution of the problem. Data are stored within the computer in the form of "bits." The word "bit" is an abbreviation for binary digit, the form of a basic unit of information within the computer. The "bit" may take the form of a magnetized spot on a magnetic tape or perhaps an electric current travelling in one of two directions which may be visualized as a light bulb which can be switched on or off automatically by the computer.

Communicating with the computer.--We communicate with computers by reading in a program, which gives the computer a detailed description of business problems which are expressed in ten digits, zero through nine, combinations of the alphabets and some special characters. However, the computer components used for storage have only two possible

conditions--"on" or "off," positive or negative, just as a light bulb has two states--on and off. In the computer, "on" represents a "1" and "off" represents "0," various combinations can represent numbers or letters. Using 46 as an example in the decimal system, each digital column is worth 10 times the one to its right. The 6 in 46 represents 6 units or one's; the 4 in the next column to the left represents 4 tens or 40. Forty plus 6 is 46.

10,000	1000	100	10	1
0	0	0	4	6

The binary system which uses 1's and 0's work the same way, except each column is worth only two times the value of the one to its right. To write 46 in binary, place 1's in the columns that add up to 46 and 0's in the rest. The answer: 101110 is the binary equivalent of the decimal 46. One 32 plus one 8, plus one 4, plus one 2, equals 46.

32	16	8	4	2	1
1	0	1	1	1	0

Computations for the conversion of the integer part of the decimal number is given as follows:

<u>Decimal</u>	"Surplus ones"	<u>Binary</u> (remainder)
<u>2/46</u>	0	r_0
<u>2/23</u>	1	r_1
<u>2/11</u>	1	r_2
<u>2/ 5</u>	1	r_3
<u>2/ 2</u>	0	r_4
<u>2/ 1</u>	1	r_5 (Senior digit)
0		

Although the processing is performed in the binary mode, the computer gives the answer in a usable form, output. Output may take several forms: (1) printed results at a rate of 100 lines per minute--reports, listings, checks, invoices, et cetera; (2) automatic typewriter printout to inquiries; (3) telephone messages from sounds recorded on a magnetic drum; (4) or even in the "input" form of punch cards, magnetic tape or magnetic disks which can be processed further, et cetera.¹

The EDP Bookkeeping System

The EDP Bookkeeping System is the solution to the accountant's mounting business problems which require: (1) the assembly of information from one or more files, (2) the sorting or re-classification of data, and (3) the posting of

¹International Business Machines Corporation, What Is A Computer? (Armonk, New York, 1966), p. 4.

re-arranged or supplemented information to one or more files. The stored program feature of the computer makes EDP Bookkeeping effective by enabling the computer to treat instructions as data by modifying, adding to, or manipulating them. The bookkeeping problems solved by accountants are characterized as having solutions of a vast amount of initial information (input) which requires simple calculations to obtain the proper output such as earnings for payrolls, billings, handling of discounts and invoices. The accountant of the past saw the ideal situation as having ready accessibility of stored numerical information, high speed arithmetic handling and arrangement of data.¹ These are the basic features of the EDP Bookkeeping System which will be compared to the manual system.

Basic accounting operations.--The basic accounting operations of the EDP Bookkeeping Systems are the same as those under the manual system, however, they are executed within the EDP unit. The basic operations are: (1) transportation, (2) reference to files, (3) transcription, and (4) manipulation and storage. An example of the basic steps being carried out under the manual system is the processing of a payment on account by a customer. After the payment is

¹Adamson, et al., op. cit., p. 15.

received, a document showing amount and source is sent (transportation) to an accounts receivable clerk who looks up the customer's account in the files (reference), copies amount on paper (transcription), subtracts the payment (manipulation), enters the new balances in the account (transcription), and replaces the account card in the file (storage).¹ The electronic data processing system requires the same steps, however, they are regarded as one physical step because they are completely executed in the mechanism of the computer.

Design.--The elements of the EDP System are easily compared with those of the manual system. The basic factors of designing and planning of the manual system differ from those of the EDP System. The designer of the manual system is the accountant who may set up manual bookkeeping by simply buying a set of ledgers, designing a chart of accounts and waiting for the input documents to arrive. He may postpone decisions regarding unusual or non-routine items until the items actually occur. In contrast, the designer of the EDP System may not be the accountant. Other persons who may design the system include the statistician and the production control engineer. The planning of the

¹Ibid.

system is more complex than that of the manual system. A preliminary analysis of the application of the system must be prepared before the installation. Non-routine and unusual items are considered when analyzing the application. In addition, a computer program is written to process these details prior to the arrival of the input document in the installation. This is one reason that the time required to set up on an EDP System is longer than that required to set up a manual system.¹

Coding.--The first step in preparing an EDP System is to reduce all of the data entering the system to a set of basic units of information which will not require further subdivision for later analysis. Subsequently, a code is attached to each of these basic units for the purpose of definite identification for convenience in handling, to provide an audit trail for tracing transactions from financial statements back to their origin. Therefore, it is necessary for the code number to describe every relevant characteristic of the unit of information which may be required later. For example, a job card may be coded: 7/230/A710/007/R, where 7 equals department, 230 equals welding group, A710 equals employee, R equals overtime work. The coding of the

¹McRae, op. cit., p. 15.

EDP System units differs from that of the manual accounting system ledger accounts in terms of details and its practicability for analysis.¹

Entering the data into the system.--The direct recording method and double entry principles of the manual bookkeeping systems contrasts with the indirect recording method and poly-entry principle of the EDP System. The manual system recording is directly into the books of account, either individually or by way of summarized totals. Under the EDP System, data must be transferred to some form of coded intermediary document such as a punch card before processing which is an added step. However, the poly-entry principle makes possible multiple classifications as opposed to the double entry principle. The intermediary document, i.e. punch card, can be entered into the systems an infinite number of times to produce a variety of reports. The advantage of this procedure is that all reports are based on the same nucleus of data, thereby diminishing the probability of error.²

Sequential processing.--The probability of error is great under a manual system because an input voucher is

¹Ibid., p. 52.

²Ibid.

transferred from person to person many times. For example, from a coding clerk to a comptometer operator to a ledger clerk to a filing clerk as a measure of preventing fraud. In contrast, all processing subsequent to the input of data under the system such as sorting, calculating, posting and recording is carried on automatically within the machine. This feature, sequential processing, is another factor which contributes to lessening the probability of making an error while reducing the required time to a minimum of seconds.

The steps are uniformly executed at specific times through the use of a control unit which serves as a coordinating device which interprets designated information as instructions, relays the instructions to particular functional units within the systems and keeps track of the program being executed.¹ The control unit assumes command of operations in carrying out the program after the read-in of the instructions and data has been completed. An instruction is distinguished from data by the addition of a unique digit to a computer word on the designation of particular digits within a word. The process is usually executed as follows: instructions stored in the first designated memory

¹Gardner M. Jones, Electronics in Business (East Lansing: State Board of Agriculture of the State of Michigan, 1958), p. 27.

location is brought into the control unit which reads and interprets the digits representing an instruction and reads the digits representing the location of the data to be used; control is transferred to the functional unit responsible for carrying out the particular operation (add, subtract, store, et cetera) required, upon completion of execution of one instruction, the next instruction is read and executed.¹

However, the manual system does have some advantages over the EDP system. One advantage is its simplicity in dealing with random inquiries which are defined as the request for a single unit of information. Under a manual system, the unit data is readily accessible. The accountant has the ability to imagine and is thereby able to cope with unexpected situations.

Nevertheless, the inability of the computer to form judgments may be considered an asset. For example, a very capable clerk may bypass standard procedure; whereas a computer cannot deliberately ignore prescribed routine. Its routine is stated in a program of instructions: once it has been given the right program, the possibility that it might use the wrong one ceases.² Since it cannot deviate from the

¹Ibid.

²Felix Kaufman and Leo Schmidt, "Auditing Electronic Records," Accounting Review (January, 1957), 35.

programmed instructions, it performs consistently throughout the processing of large masses of information. The lack of judgment may be offset by the insertion of branching instructions into the program. The instructions may contain an infinite number of instructions. The branching instructions consists of a series of conditional instructions which are usually given in the form of "if" statements.¹

The possibility of the occurrence of unexpected situations is given particular attention during the initial stage of EDP System planning. Therefore, computer programs are written with a flexibility for alternative instructions and programs are written for random inquiries prior to the inquiry for records likely to be interrogated. Although this is a precautionary measure, inquiries may cause a bit of difficulty in regard to the time factor. Inquiries may not be granted until the time of processing runs out due to the economics of setting up a job on the computer just to answer a few random inquiries.²

Analysis of data.--Among the advantages of the EDP

¹A simplified discussion of the "If Statement" is given by Donald Dimitry and Thomas Mott, Jr., Introduction to Fortran IV (New York: Holt, Rinehart and Winston, 1966), pp. 104-108, 270-273.

²McRae, op. cit., p. 53.

System that offset the disadvantages of random inquiries and other unexpected items is its advantage in compiling statistical reports. The coding of each unit of information at its source, which is done when designing the system, enables the computer to assemble and reassemble the units into any required pattern of the computer program. A common term applied to this feature is "information retrieval."

The new book of accounts.--At the beginning of the comparison, the installation of a manual system was considered simple on the basis of the simplicity of charting accounts in a set of ledgers, the manual books of accounts. In contrast, the books of accounts of the EDP system are stored on panels, cards and magnetic tapes.¹ The punch cards do not present a real problem because their contents may be printed at the top of each card. However, magnetic tapes differ from the manual books in that: (1) for all practical purposes they are invisible which means that the accountant is dependent on an EDP operator for translation, (2) an intermediary device, the computer, is necessary to translate the magnetic records into a hard copy "format" suitable for audit, and (3) a record can be erased without a trace and another record substituted in its place.

¹Ibid.

A detailed discussion of the actual application of the new books of account and series of computer runs is discussed by T. W. McRae, The Impact of the Computer on Accounting on pages 51 to 81.

CHAPTER III

SEVEN KEY STEPS IN PLANNING THE COMPUTER INSTALLATION AND RELATED PROBLEMS

The seven key steps in planning the installation of a sound data processing system should be executed in the sequence presented:

1. Identify Problems
2. Set Objectives
3. Determine Requirements
4. Design System
5. Select Equipment
6. Determine Economics
7. Evaluate Feasibility¹

Identify Problems

The failure to identify problems before the installation is one of the factors which contribute most problems to the EDP system after installation. Some common problems

¹Gordon Hamrick and Donald B. Dixon. Data Processing Systems. An address for managers. (Arthur Andersen and Company, 1967), p. 9.

of the controller's division are analysis of data for management accounting reports; high costs for clerical staff due to the tremendous amount of billings; meeting report deadlines because of too much input for present staff to digest. However, the problem should not be considered only in terms of the controller's division, one segment of the organization, but with the viewpoint of the whole organization. Identifying problems is one of the most difficult problems because of the possibility of becoming confused as to whether the need is really for more timely information or for more timely people who use information well. However, the problems should be explored to the fullest extent as opposed to starting with a solution, the computer, and then having to hunt for the specific problems which it is to solve. It is most beneficial to "know your illness before you take your medicine." Nevertheless, problems are not necessary prerequisites for a computer installation.¹

Set Objectives

The objectives should be specific and clearly stated to avoid another problem of an installation completely off target. It is not enough to say "to obtain the maximum

¹Ibid., pp. 9-15.

profit" which is the general overall goal of all industries. Examples of specific objectives are: (1) information for better performance and control, (2) cost reduction, and (3) effecting a change in the organizational structure for centralization or decentralization.

The identification of problems or needs and the establishment of objectives are essential factors for the determination of requirements. The following is an illustration of a typical system which was designed and installed without any specific objectives. It performed the following functions:

Booked and confirmed customer orders; processed all shipping documents and invoices; maintained accounts receivable; detail and prepared aged trial balances; prepared regular inventory balance reports for raw materials, work in process, and finished goods, monthly reports, periodic sales analyses....¹

One evaluating this system on the basis of the functions that it performs would think that this covered the gamut of the essential functions of a typical controller rather well --which is true. However, in this particular case, operating management found the system intolerable. After a thorough analysis, their problems were identified as poor customer service and excessive inventory. On the basis of the

¹Ibid., p. 15.

analysis, they should have established the following objectives:

...to reduce elapsed time from order to shipment, ... reduce back orders to a fixed per cent, ... improve inventory turnover, ... develop some product contribution information.¹

The requirements for achieving these objectives should have been a reduction of paper shuffling time for order processing and the provision of reports which would pinpoint problem areas and aid in better scheduling of production. Not one of these requirements was satisfied by the system installed because the problems were not identified, no objectives were set for determining the proper requirements.

The resulting conclusion is that the requirements for the design of the system should be determined in light of the particular problems of the company before selecting the equipment to achieve the objectives of the system--not vice versa. (See Illustration I in the Appendix)

However, before reaching the stage of determining the requirements in terms of specific equipment, a justification study should be conducted in order for the company to get a broad view of its present situation as to whether or not increased efficiency and lowered costs could be achieved

¹Ibid., p. 17.

through systems improvement rather than through the installation of an EDP system. If this is not possible, the next problem is to determine whether the company can afford the cost and time for a thorough systems study, costs for programming and costs of testing the program which can be considerably higher than the cost of the basic machines. If the conclusion is to continue the EDP planning project, a consulting organization, preferably a CPA firm which provides administrative services, such as Arthur Andersen and Company, which has a staff of specialists with both accounting and systems experience, should be engaged to assist in the following aspects of EDP planning:¹

1. Outlining the feasibility study.
2. Choosing the most suitable equipment for the job.
3. Resolving internal disagreements by acting as an impartial arbiter.
4. Examining and checking plans before they are implemented.²

¹Consulting is one of the three levels for the accountant to enter the EDP practice according to Victor E. Millar, C.P.A., "The Three Levels of EDP," Journal of Accountancy (February, 1967). For this reason, the role of the consultant will be given particular attention along with that of the controller and the auditor.

²McRae, op. cit., p. 194.

Engaging a consulting organization is more feasible than hiring the required specialists outright because: (1) specialists are scarce, (2) personnel of this calibre are very expensive to maintain, (3) they are not needed full-time after the installation. In addition, training members of the present staff to the required level of proficiency would be too expensive--both monetarily and time wise. The consultant's evaluation of the present system in terms of EDP applicability is likely to be more valid than that of the controller or the computer manufacturers who may submit proposals. By virtue of his experience and profession, he has more knowledge of EDP than the controller who should work with him and he has nothing to gain by over selling EDP capabilities as does the manufacturer.

Determining Requirements

The preliminary information on the problems and needs from the controller's point of view will first be evaluated by the consultant to determine whether a computer installation is to offer benefits in terms long-run savings achieved through a better and more efficient system or a quick payoff through reducing the number of workers needed in a few major high-volume operations. For the purposes of this study, it is assumed that the company's goal is to eventually achieve

a company-wide system through which all major paper work and information flows will lead to or stem from the computer, with the controller's division as a starting point due to the high-volume of paper work which has slowed the preparation of management accounting reports to the point of ineffectiveness for decision-making.

The minimum requirements of the system should be to provide permanent records of transactions with sufficient printout records and financial statements to provide an audit trail from the original source of data to the financial statements. The general ledger of the EDP system must contain the same details as the conventional journal. Each debit and credit of every accounting transaction is to be individually entered, line by line, in the general ledger and by use of data, references, and source codes may be readily traced back to the source documents. The financial statements produced should be the balance sheet, operating statement, government reports required including income tax return, payroll records for Federal Insurance Act, et cetera.

The second step in the study is to study the present system. The particular area of the controller's division selected as the initial application of the computer installation is chosen after the consultant has: (1) reviewed

whatever the company has available in written or graphic form describing its pattern of information flows--organization charts, departmental flow charts, tables of equipment and personnel for major areas; (2) listed major files and their uses and traced major data patterns among departments while paying particular attention to problem areas--understaffing, inadequate equipment, illogical work flow sequence, deviation of work flow sequence, backtracing in work flow sequence; (3) listed major areas by importance in terms of the costs of work performed and the immediate importance to the company of having the work done accurately and swiftly; (4) matched the areas by degree of importance with computer capabilities to determine just how much improvement in terms of cost or increased efficiency the installation of the electronic data processing system might bring to the area of consideration in the controller's division; (5) worked out rough cost, savings and profit figures; (6) determined the primary application of the computer in light of the preceding key steps; (7) while considering the objectives set forth by the company during the preliminary EDP planning prior to his entrance and the results of his initial study, he outlines what the EDP system should try to accomplish, prepares simplified overall flow charts of the present system and the

proposed new system which should be precise enough to make clear the major lines of communication between departments and the major work flows within the department.¹

At this point an EDP study committee is formed for the purpose of reviewing with the analyst the objectives he has outlined, to fill in details and to point out the aspects of the system not considered. The committee is composed of knowledgeable representatives, generally managers, from each of the departments which will be directly affected by the installation. Representatives from finance, production and sales should always be present.

Design System

The EDP System.--A system is defined for the purpose of this study as the interaction of one or more programs and human actions which perform a function. An example of an accounting EDP system is the data generated by a sale and entered into a computer which can immediately have the effect of adjusting the inventory and receivables; providing billing data and shipping data; providing a basis for many

¹Thomas J. Kelly and John R. Noland, "The EDP Feasibility Study," Accounting and the Computer (New York: The American Institute of Certified Public Accountants, 1966), pp. 308-310.

statistical evaluations, et cetera. After the justification study, a general design should be made. Although the general design is refined from the feasibility study to include various details, the scope of this study warrants the discussion of both the design and related problems in the same step.

The first and probably most difficult problem of designing the system is to define the system requirements. The controller who has struggled for the acceptance of the justification study is tempted to have the system designed for every possible convention. If he does, the system will never be installed before the system needs redesigning because the larger systems take about one and a half years for the results to become evident and the smaller ones require at least six months. In addition, the requirements must be defined with consideration given to the potential growth of the system. Therefore, to provide accurate and timely information for the conduct of a business, the EDP system must collect data, validate it, arrange it, file it, summarize it and display it in appropriate reports. The report specification must include the type, frequency, content and purpose of each report so that the system analyst can design the input data formats, files, and programs accordingly. The

analyst designs a system that will produce required results from the available data. Therefore, the definition requires a step by step analysis of each output requirement, a relating of output requirements to input requirements, and a reason for processing the data needed to meet the requirements.¹ Other aspects of the process of designing the system are streamlining present office procedure; replacement of obsolete or inefficient forms; improvement in accounting methods; and elimination of unnecessary reports.

The controller must indirectly control the analyst who tends to be satisfied with how and never really delves into the what and why of designing an improved system. This may be done by obtaining the answers to questions starting with who, what, when, why and where, often assist in developing the correct purpose of a form, report or procedure.² He should suggest and approve the audit techniques used to control and evaluate the system if his external auditor is not available.

Auditing an EDP System.--Auditing problems under the

¹Honeywell Data Processing Division, Customers' Guide - Computer System Planning and Control (December, 1965), pp. 2-7.

²National Cash Register Company, "System and Design," EDP Information (September, 1966), 6.

manual accounting system involves verification of individual items with emphasis on arithmetical accuracy and posting figures from one document to another. Whereas the EDP system audit involves checking the total system by verifying the input documents and seeing that subsequent procedure are carried out as planned.

In addition to locating typical accounting problems the auditor performing an internal EDP audit has to do the following:

1. Keep a record of
 - a. jobs being processed;
 - b. programs in use;
 - c. master (magnetic tape) files;
 - d. authorized alteration to programs and master files, because the magnetic tapes may be erased without a trace which creates the problem of having to prevent fraud.
2. Look after log books once they are completed.
3. Carry out sampling audits on all of this material.

Common methods used to solve fraud and error problems are in the following:

1. Establishment of closed shop policy; whereby, divisions being serviced are not given direct access to the computer.

2. Installation of a console typewriter log book which automatically types up manipulation of switches on the console.
3. Incorporation of program control to guard against writing over the wrong record.

In addition, errors may be minimized using only high calibre of coding clerks, and insisting upon his taking advantage of mechanical aids for verifying input documents--validating checks on acceptable codes or a self-checking number system. The department submitting the input documents may be urged to submit them in batches and supply control totals for each batch.

If an error should occur, the auditor has the problem of clearly defining the routine for error correction. The types of errors and their frequency should be noted and used to evaluate programs, systems designs, et cetera.

To check on the system the auditor may use one of the following methods:

1. The black box approach
2. Job simulation
3. Audits in depth using statistical sampling
4. Auditing the job file directly
5. Audit by exception

The auditor with little or no knowledge of EDP may use the black box approach; that is, feed certain data to the system and make a statistical analysis of the output resulting from this input. The job simulation method does not require knowledge of EDP. However, an intricate comprehensive sample job must be designed which may be run through the computer program--tapes, lead cards, et cetera, so that the answer from EDP accounting systems may be compared with answers of the sample.¹

Even if the recommended procedures for error prevention were carried out, an audit in depth should be performed because an error in a program will always produce the same results and the errors will be randomly scattered; whereas, errors in a manual system tend to bunch together. The audit in depth approach involves taking a small sample and checking it in detail through all of the routines involved.²

The accountant who wants to build up a knowledge of the job of auditing and EDP system may audit the job file with the assistance of their programmer, who must explain why he did what he did in constructing flow charts. Using

¹McRae, op. cit., p. 77.

²Ibid.

the general chart of the flow of paperwork into and out of the computer room, he can get a view of the procedures and locate the control points in the system.

In addition to creating problems for the auditor, the computer solves several. One is the problem persuading audit clerks to select random samples, the cost of which is recurring. The preliminary cost of writing the program for random sample selection is a once-and-for-all cost and the selection is a true random sample because the computer lacks judgement. Lack of judgement is an advantage because the computer maintains a disciplined system of selecting sample items without regard for the size of the population. In this case the size must be large because of the small proportion of errors in relation to the total population.

The "audit by exception" approach may be employed to check the total EDP system by using a comparative or standard set of values, as a basis for comparing items of the EDP system which is available on punched cards or magnetic tape. Items that vary significantly are pulled out through the use of a program written for this purpose so that the auditor can investigate them thoroughly.¹ Not only is this method effective, but it requires a minimum of time; thereby freeing

¹Ibid., p. 181.

the auditor to insert additional checks.

Another auditing problem is the recovery of historical data. The current balance on any account is kept in random access storage, but the various debits and credits which make up this amount are lost once the balance is adjusted. This problem may be solved by storing all incoming data on magnetic tapes initially in random order, but adequately coded; during slack time these data can be sorted into proper sequence and stored away on the requisite tape reel for future interrogation. Since tape reels can be removed from their tape units and stored in a tape library, the capacity of tape storage is virtually infinite. However, historical data which is frequently interrogated can be placed in the random access storage by using such storage devices as the disc pack.

General accounting.--The first applications usually are those which provide an immediate payoff in terms of dollar savings and those which the fundamental system needs as a groundwork for gradual growth into a total systems approach to management accounting. However, the accountant is very aware of the fact that the specific procedures to be adapted to the computer initially have to be chosen with great care. Choosing the specific applications is a problem

in itself which may be solved by using the following criteria based on volume, cyclical processing, and repetition: (1) there must be a considerable volume of simple calculations or of printing, i.e., invoicing; (2) the logic of the problem must contain many special cases and exceptions, i.e., payroll; (3) the answer required must be precise, i.e., price; (4) the job must be processed on a cyclic pattern, i.e., monthly; (5) the input data should be such that they can be used in a variety of ways, i.e., purchase order card may be used to make an invoice, a sales analysis listing, a stock credit, et cetera.¹

Two other problems which confront the accountant under the EDP system are those of making random inquiries regarding specific transactions and preparing a report without notice. When using the conventional method of bookkeeping, the accountant has ready access to his data in ledgers for obtaining single units of information. Under the EDP system records are on tapes which makes it impractical to request such information from computer operators who would have to stop the present run, change tapes and feed another program to the computer just to answer one question. If there are numerous random inquiries, in spite of the

¹Ibid., p. 100.

accountant's attempt to minimize them, the most practical solution is to schedule a special run at the end of the day or, if possible, postpone answering the inquiry until the appropriate tape is run through the computer. A technical solution is to incorporate a sophisticated tape-changing routine or equipment especially designed for answering random inquiries.¹ A timing problem is created when a report is requested without notice. The solutions usually employed are programs incorporated in the initial system's design or an accessible library of utility programs is prepared by the programming staff for such requests because an on-the-spot request for a special report will require a few hours of preparation. Even if a program is available, it may not be possible to get a complete run because of the previously scheduled runs and because the cost of a special run will not be justified in terms of the benefits received from the report.

Another problem is to maintain efficient report processing by limiting the number of reports and minimizing printout. The speed of the computer which is its most powerful feature, makes it possible to produce a great deal of data which is often confused with information. This vast

¹Ibid., pp. 103-104.

amount of data causes the computer to be inefficiently used and the printout is slower than the computations which result in a bottleneck of information when voluminous data is printed out. Analyzing voluminous data for significant information is time consuming. Time required to produce a management accounting report should be at a minimum because the reporting emphasis has changed from merely showing the position of the business to the timely reporting of variances and changes, primarily those on which management can act in terms of managerial planning of the assets, revenues and expenses.¹ One solution to this problem has been the application of the "exceptions" principle which entails placing the expected pattern of events into the computer storage and allowing the computer to make comparisons between the expected pattern and the actual situation. The computer can be programmed to compare these and take the appropriate action. An example of this situation would be to instruct the computer to print a report if the variance is significant. The level of significant variance may be determined by the accountant who may also review the standards for the exception principles in order to avoid basing levels

¹Jones, op. cit., p. 64.

of significance on obsolete criteria.¹

Cyclic processing which is a criterion for adapting an accounting procedure to the computer may also present the problem of imbalance in the flow of work in the EDP department. This is due to the imbalance of interlocking of cycles. For example, four invoicing periods equal one statement period. Since reports may be due daily, weekly, monthly, et cetera, during interlocking peaks the EDP department has to work over-time. On the other hand, they are idle or do not work to full capacity during the intervals. This situation may be remedied if the accountant staggers his reporting periods so that some statistical reports fall in the middle of the period.² The accountant should make sure that input documents arrive on time because late arrival of vital documents can throw the entire EDP department off schedule which is very costly. On the other hand, as the system develops, a double shift schedule will result in savings. The cost of the second shift is about 20 per cent to 25 per cent of the first shift supplying the same amount of data. This does not create problems for employees. Many favor it because it gives them more free time during the day.

¹McRae, op. cit., p. 106.

²Ibid., pp. 106-107.

Although the reporting process may be speeded up at the output unit by adapting the "exception principle" and staggering the work flow, a basic accounting procedure regarding input may hinder the effectiveness of report preparation. Due to the generally accepted accounting procedure of closing books only after all transactions for the period are recorded in the accounts, a report may be held up because minor transactions or exceptions have to be entered in the accounts. The argument against this traditional procedure is that the accountants are inconsistent in their procedures because of their insistence on exactness with regard to minor transactions; whereas, they readily consent to the use of broad estimates of cost expirations such as depreciation and amortization. This procedure is proper for the purpose of matching expenses and revenues of the same period if they are significant when comparing efforts with results. Nevertheless, the inclusion of every detail of expense relating to minor transactions or exceptions while approximating other kinds is considered a hindrance to the reporting preparation process without justification based on consistency of procedures. However, this is not due to the fact that the accountants are victims of their habits. This is a perfectly logical procedure when considering the manual method of keeping

records because the assembly of statement information was a process sufficiently slow so that all information was in by the time the accountants were ready to present the summaries of affairs.¹

Another problem relating to accounting accuracy is that of guarding against the loss of proof of accounting accuracy. The loss of accuracy is possible because the records are kept invisibly and the recording of transactions is electronic which affords the possibility of a destructive read-in on stored transactions; that is, a new record can be read into the computer which can replace the old transaction without a trace. The same situation is applicable to storage of transactions on magnetic tape because the tape can be erased completely. Four measures which may be taken to guard against the loss of accuracy are: (1) duplicate records of all transactions, (2) retain all original documents, (3) entrust only competent persons with the operation of the electronic equipment, and (4) allow only certain immediately concerned personnel to work with the equipment or handle the tape files.

The distinct advantage of the manual system for error detection by reviewing documents will be lost with the

¹Jones, op. cit., pp. 53-54.

installation of the EDP system. Experienced personnel of the manual system developed a sensitivity to errors and inconsistencies in the documents they processed, the electronic equipment cannot detect errors unless a self-check is built into the program. Using various control measures of the manual system, the computer can be programmed to test data for particular types of figure errors. Checks may be instituted for numbers, quantities, or prices of an obviously impossible magnitude. Examples of cases for pre-established limits are 83 hours instead of the limit 38 hours, \$7.15 per hour instead of the limit of \$1.75. In addition, proof totals are generated within the computer. For example, in a payroll computation, the computer will determine the total earnings for the payroll and in distributing the wages to jobs and/or departments will accumulate other sets of totals to be proved to the total earnings. Specifically, the computer can ascertain that: (1) gross pay equals the sum of departmental charges, (2) gross pay equals the sum of charges to jobs and to overhead accounts, and (3) net pay plus totals of all classes of deductions equals gross pay. A proof total may also be instituted to check the accuracy of read-in information by having data read in twice, each time summing the information as data, and comparing the sums resulting

from the two read-ins. If the totals agree, the machine has probably read in consistently and correctly.

Programming.--To effectively implement the proposed systems plans including auditing and general accounting, appropriate computer programs must be written and this process presents additional problems. The first programming problem is to determine the appropriate language for the system. A compiler language is usually chosen which has the following characteristics: (1) easily understood by management and other reviewers with less reliance on flow charts, (2) easily mastered, (3) problem-oriented rather than machine-oriented. Processing options suggest to the programmer how they can be used, (4) includes a more exhaustive set of diagnostic routines to detect programming errors, (5) easily revised and self-documenting, (6) programs are written and become operational quicker than if written in assembly language, and (7) program maintenance is enhanced as the ability to transfer programs among programming staff.¹

The problem-oriented language of major concern to business data processing is COBOL, the Common Business Oriented Language which is near English in form. The

¹Honeywell Data Processing Division, op. cit., p. (2-9).

problem-oriented language of the engineer and mathematician is FORTRAN or Formula Translating System which is used for solving technical problems.¹

However, a few programs may be written in assembly language if: (1) the program design and performance are stable and no major revisions are expected, (2) the program is sufficiently time consuming because a program written in a compiler language will normally operate at 85 to 80 per cent of the speed of the same program written by experienced programmer in assembly language, (3) it is used very frequently, and (4) computer time becomes scarce enough to warrant the effort.²

In a system of computer programs all referring to the same set of data, the procedure of defining and including data as a part of the computer program that operates on that data becomes quite cumbersome and results in wasted computer time. This situation may be avoided by excluding the data as a part of the computer program and referencing them through a central index or master inventory of data files. This procedure also allows for the over-all

¹National Cash Register Company, op. cit., p. Prog. 2.

²Honeywell Data Processing Division, op. cit.

unification and cohesion of the program system which serves as a significant point of audit control because with different groups of the company using this data base inconsistencies are very obvious.¹

Other programming errors such as those of coding and punching may be detected by a scrutiny of the trial balance and may be corrected before the preparation of the general ledger and financial statements. Adjusting entries based on the current period's operations must be entered by estimation. A major cause of coding errors is poor planning. Many times a new code should be adopted to replace the manual codes, but are not because of the difficulty that accounting clerks would have in adjusting to them. This difficulty may be eliminated by inserting a translation routine into the computer program in order to have two codes, one for the clerks and one for the computer.

After considering preceding potential problems and possible solution, the EDP study group analyzes the major system's areas of the company, modifies and corrects accordingly;

¹M. Blauer and J. J. Connelly, Computer Research Studies: Software Trends - Hardware Characteristics, Vol. V. A report prepared by Systems Development Corporation (New York: The American Institute of Certified Public Accountants, 1966), p. 15.

it simplifies where possible by eliminating or consolidating reports and forms that can be achieved within the present system. Emphasis is placed on eliminating unnecessary items from the present system in order to allow the necessary parts of the system to be seen in much clearer perspective and thus making it simpler, in terms of the abilities of the electronic data processor, to make really significant systems improvements, to align functions in the most logical order, and not only to transfer clerical processing tasks to the computer but also to eliminate some clerical processing tasks entirely because of the abilities of the computer.

Realizing that the computer will have an effect on the personnel as well as on the basic procedures, an employee study is conducted to determine the impact of personnel problems on the system.

Personnel.--Assuming that the center is of insufficient administrative importance to justify its standing as autonomous division, the controller's division is usually selected to second staff the EDP center because it has personnel with more experience than any other group in getting and distributing information across departmental lines which is more in line with the nature of data processing activity

than would be the activities of an operating division.¹

Along with the division's increase of status in the corporate organization are the problems of: (1) restructuring the controller's staff, (2) selecting members of the staff, (3) human relations difficulty, and (4) training the staff.

A restructured controller's staff should include the following groups:

1. A systems and procedures group, charged with development of methods for accomplishing information-gathering, processing, and reporting throughout the firm.
2. A budget and planning group, charged with preparation of plans for prospective activities in regard to both production and finance.
3. A reports group, charged with presentation of reports and all outgoing information services; included would be general accounting, production analyses, payroll, cost reports, and statistical studies.
4. An audit group, charged with determination of existence of adequate controls and their

¹Jones, op. cit., p. 61.

effectiveness in use.

5. An operating group, charged with performing the actual data processing.

See Illustration II in the Appendix for an overview of the organization structure of the controller's division.

Selecting particular members of the staff.--Operations group includes analysts, programmers, coders and machine operators for the electronic data processing machinery and for data preparation equipment. In addition to the main problems of selecting a staff, the chief accountant must overcome the temptation to send least competent clerks to the EDP department because efficiency is most rewarding and inefficiency is the most costly. As a preventive measure, aptitude tests may be given to those persons who may be transferred as possible programmer trainees. These tests may be secured from a computer manufacturer. In addition, he can consider the same qualities that made a good bookkeeper as general criteria--skills of logical thought, painstaking accuracy, neatness and diligence.

In selecting his staff he must consider up-grading the accounting department which will be responsible for more specialized problems, requiring skills for systems work, budgeting, schedule making and analysis. Therefore, his

staff must be composed of teams of accounting-oriented personnel, who are able to study accounting systems and other business problems and cope with the scientific details of the system.

Criteria for selecting personnel.--Typical criteria for selecting personnel are as follows:

1. First choice--members of accounting, production, finance, sale and personnel divisions of the company.
2. Members with company experience of several years in departmental jobs.
3. Capacity to absorb new ideas and implement them.

System analyst:

1. Intellectual perception, objectivity proving skills and educational background which permit him to grasp intricate administrative methods.
2. Must be able to communicate in oral and written reports.
3. Must be cooperative and tactful because his job involves inquiring into how another person does his particular job.
4. He should have a programmer's understanding of computer equipment, its capabilities and

limitations, manufacturer's programming percepts and conventions.

5. A college degree is desired.
6. Be current in new developments in the analytic art, corporative practices and advanced management techniques.¹

Programmer:

1. One who can work alone as well as with a team.
2. Has an inquiring mind.
3. Tenacious in his zeal to finish a job.
4. Accounting experience option, however, it would be helpful if he were a specialist in accounting.
5. Education, college degree, backgrounds in an analytical selection features.
6. Demonstrate ability to perform programming tasks through the use of aptitude tests, et cetera.²

Data processing operator:

1. Reliable.
2. Understand computer programming.
3. High school education.

¹National Cash Register Company, "EDP Staff Selection and Training," EDP Information (December, 1965), 2.

²Ibid.

4. Aptitude, capacity and desire for a full career
in data processing.¹

During the planning process of restructuring the controller's division and establishing the criteria of staff selection, the controller must deal with the human relations problems of his department. The first problem of human relations, resistance to the change of systems may be solved by eliminating the fear of employment by present staff member. It has been found that mass unemployment does not result from EDP installation because: (1) the planning period for installation usually extends over twelve to twenty-four months which has normal attrition, (2) data processing center absorbs members of old staff, (3) demands of other departments take care of the remainder, and (4) conversion is done through a gradual process,--one application at a time.²

Another human relations problem is that of the resistance to the general pooling of clerical effort as opposed to the old arrangement of having a concentration of clerical strength in particular fields of accounting and

¹Ibid.

²Jones, op. cit., pp. 61-63.

other paper work groups because there may be some supervisors whose authority may be reduced in proportion to the decrease in the number of subordinates removed from his charge. According to Dean William S. Fuller of the Harvard Business School, this type of resistance may be prevented by planning, advising and assistance and stimulating the total group by counseling.¹ For example, the supervisors may be given more elaborate titles, or given a status-gaining promotion; the old employees may be assured of a position; in addition, a wage increase may be a supplemental compensation.

A future personnel problem that the controller must prepare for is the retention of his EDP staff. Once a basic knowledge of systems analysis or programming is gained, the systems and programming personnel are highly mobile not only within the company, but into key positions in EDP centers of other companies. This is due to the fact that basic EDP knowledge is transferrable.

EDP training.--After the staff selection, criteria and related problems have been considered, the training plans and problems must be considered.

¹William S. Fuller, Dean of the Harvard Business School. "Resistance to Change," an address to the School of Business, Atlanta University, Atlanta, Georgia, February 16, 1967.

Planning management which usually consists of the controller, members from executive offices, sales, distribution and other affiliated departments attend manufacturing planning seminars. At these seminars they study the planning to be done, schedule each major activity and milestone event and compare their schedules against those for similar application that the manufacturer's have experienced previously. In addition, they familiarize themselves with project control tools while formulating, monitoring, evaluating and redesigning their own system design.¹

Operating management other than EDP attends seminars on EDP capabilities for operating management. The objectives of the seminar are to:

1. Describe the terminology and basic principles with which operating managements must deal when working with the systems designer.
2. Explain how the computer can aid a specific department in solving its problems.
3. Describe the types of information the analyst requires.
4. Discuss information flows, type and format, input/output data, data checks, and the types of reports

¹Honeywell, op. cit., p. (2-19).

that are obtainable from the system.

5. Establish mutual trust and an understanding of the problems that will be solved cooperatively during transition to the new procedures.

Personnel training should begin soon after the implementation plan is formulated and schedules are established. On-the-job training is the one characteristic that all members of the controller's staff have in common. As a result, he has the problem of reviewing training specifications for his staff by groups and determining the content of training sessions on the basis of the abilities and experience of selected personnel, the depth of training required for various groups, the selected programming language, and the application to be undertaken.

The controller trainee will be trained in specialized departments such as budgeting, corporate systems, accounting, auditing and data processing systems where he will be working directly with operating management planning and implementing tailored improvements in management information systems.

Systems personnel are trained in equipment characteristics and selected programming language. Whereas, programmers are trained in the selected programming language

and in the characteristics of the equipment. Classroom instruction is of value in learning programming; however, the real outcome is from the actual writing of a program. In addition, the "team" approach to programming is a method of training that utilize a built-in, on-the-job training course. However, this may result in an irregularly trained staff because of individual talent and temperament and lack of uniformity of training in such areas as use of software commands and local programming conventions. After the employee study is completed, an appropriate system is designed on the basis of the data processing requirements for the present and in light of the growth potential of the company. With this information the EDP study group may proceed to select the equipment and determine the economics of an installation.

Select Equipment

The system should be designed before the equipment is selected in order to select a computer on the basis of a definite job to be done which will contribute to the attainment of the desired objectives. This is another area where the controller should be assisted by a consultant who is qualified to assess the true potential of the equipment and

has had experience with many types of equipment. The controller who attempts to select the equipment, without a consultant on the basis of manufacturer's salesmen is likely to run into problems after the installation because of the tendency for manufacturers to over sell the potential of equipment without mentioning the required auxiliary equipment which must be purchased in the future when the system is fully implemented. In addition, the selection decision is very difficult because of the competition of manufacturers and the various lines of equipment carried by each which are equally adequate for the desired system.

In addition to the questions asked of manufacturers submitting proposals to be discussed under the item "Determine Economics," the following may serve as a checklist for computer evaluation in relation to the specific objectives of the system:

1. Is it a new machine that has the most advanced technological features available?
2. How much data is to be processed by the system?
3. What is the required response time or how fast must data be processed?
4. Is the main memory processing speed adequate in relation to the amount of information that will

be handled by the system?

5. Is there an option on the size of the main memory whereby the equipment capability may be expanded without having to change to a different make or model of equipment?
6. Does the selection of auxiliary storage devices allow the most effective and economical combination of devices relative to data handling requirements, system information needs and allow for potential growth of the system?
7. Is there a sufficient range of "input and output" devices to fit equipment to the system requirements?
8. Are compilers provided by the manufacturers?
9. What other features relating to programming and systems are provided by each manufacturer?
10. What is the ratio of costs to benefits of each manufacturer?¹

After the specific equipment is selected, the EDP study group appraises the economics of the installation.

¹Blauer, op. cit., pp. 51-53.

Determine Economics

Problems to overcome in the appraisal of the economies of an installation through an effective cost/benefit study are: (1) lack of agreement on terminology, (2) poor understanding of product quality, (3) poor quality of cost data, and (4) the nonquantitative area of the benefits.¹

EDP cost terminology.--The existing vocabulary of data processors, economists or accountants does not include commonly accepted terms to describe the programming processes, its products and/or the personnel. As a result of their not being able to adequately describe the basic elements of the EDP center, in common terms, they can not adequately determine cost. However, the cost accountant who has been confronted with the problems of standardizing cost terminology can be a major contributor to establishing a common basis for the terminology needed for the cost analysis. A similar problem is related to standard measures of computer program performance. For example, the standard use of cost per instruction to compare programs does not give adequate consideration to the quantity of resources, time complexity of coding, programmer's ability and experience required for each program. In addition, the cost data is not accumulated

¹Ibid., pp. 8-9.

by instruction or performance which would provide a basis for determining a standard cost.

Justification of EDP system cost.--The next problem is to justify the cost of the producing the EDP system, installing and maintaining it. Justifying the costs appears to be very simple--compare the cost of the manual system with that of the EDP system and let an astronomical credit balance justify the installation. However, accountants realize that the true significance of the figures may be found in the analysis. The cost may be analyzed in terms of initial costs and fixed costs. Direct savings may be found in the following areas: (1) cost of previous equipment taken out, (2) reduction in clerical and typing staff, (3) reduction in space costs, (4) reduction in overtime, (5) reduction in communication costs--data transfer costs due to centralized accounting, and (6) reduction in supervisors.¹ Caution should be taken in attaching a great deal of weight to the reduction of costs for clerical and typing staff. It is well to remember that the quality of the new staff is much higher, so that the savings on staff may not be very substantial.

¹McRae, op. cit., p. 211.

All savings may not be measured in exact terms of dollars and cents. For example, speeding up the information flow to management and providing more accurate information undoubtedly results in substantial savings which usually are not expressed in monetary terms. Other intangible savings result from the free publicity and being able to do more complicated and larger jobs without adding clerks or other staff members due to the flexibility of the computer.

Manufacturers' proposal.--The cost of the equipment must be determined. The true cost of the equipment may be determined from the proposals submitted by manufacturers, the controller assisted by a consultant constructs a questionnaire which obtains answers to the following questions:

Acquisition:

1. What are the alternative schemes by which one may acquire the computer? (i.e., rent or lease).

Provide the cost under each of these schemes.

Regarding lease:

2. If the computer is leased, what factors does the leasing cost include? Does it include the following:
 - a. Maintenance?
 - b. Insurance?
 - c. Cost of educating staff?
 - d. Programming and systems aid?

If so, how much?

3. What is the minimum period of the leasing contract?
4. Is there a machine use limit? If so, state limit of use.
5. How much does a multiple working shift cost?
6. Having leased the machine for a period, can it be purchased outright? If so, what allowance will be given?
7. Can the monthly lease payment be altered? (i.e., by reason of inflation). If so, how often and how much?
8. On what basis will an engineer be available for our use? (i.e., sharing with another firm or full-time).

Regarding sale:

9. What is the cost of the maintenance contract?
10. Can a computer be sold back in a few years time?
If so, at what rate? Is a resale agreement available only if the computer is purchased from the same company?
11. Who pays for the transportation of the computer?
Give details.

Regarding education:

- 12. What "free" facilities are provided?
- 13. Will the manufacturer send instructors to us?
- 14. How much does the various training programs cost?

Other:

- 15. What additional cost will have to be incurred?
(air conditioning, structural alterations, card storage files, and paper handling equipment).

Analysis of cost.--After the controller has the answers to the preceding questions and has the ratio of cost-to-benefits of each manufacturer, analysis must be made of the cost of the EDP system in terms of initial cost, running cost, and fixed costs. Initial costs includes the cost of acquiring the computer, the system survey, the consultant's fee, the cost of the changeover period, cost of editing and punching the basic files, structural alterations, education of staff and initial programming and transportation and installation.

Since acquiring the computer involves a large capital investment, care must be taken in examining the alternatives. The factors favorable to outright purchasing the computer are: (1) computers enjoy a long working life; and (2) the purchaser can use the machine as much as he would

like; whereas, leasing agreements may require additional payment for multiple shift working. On the other hand, the favorable aspects of leasing are: (1) technical advancement may cause the computer to become obsolete before its working life ends, and the cost of installing a new computer would involve another heavy investment in programming and systems design, (2) leasing frees capital for more productive uses, although Donald Gant, author of "Illusions in Lease Financing," Harvard Business Review, 37, No. 2, demolishes reasons for leasing by saying that it provides novel opportunities, not increased working capital which provides increased profits, and (3) leasing makes it easier for the growing company to have adequate EDP equipment at all stages of its growth. However, the building block principle and multiple work shifts are methods of overcoming growth problems. The building block principle involves adding a few more boxes rather than acquiring a new computer.¹ (4) Leasing is insurance against repeated breakdown and heavy repairs. However, the purchaser usually signs a separate maintenance agreement with manufacturers. (5) If the system fails, the computer can be removed more painlessly by simply

¹Ibid., p. 214.

terminating the lease agreement rather than by selling the machine since the manufacturers tend to have a monopoly of computer engineers, thereby, giving them an added advantage and controlling hand in the sale of used computers. (6) The most unscientific, but popular reason for leasing a computer is that it is easier to convince the board to authorize small monthly payments than it is to persuade them to accept a single heavy initial payment.

Running costs include personnel, storage, punch cards, paper tapes, magnetic tapes, maintenance, stationery, heat, light, power, space costs, insurance, cleaning and a share of manufacturing overhead. The fixed costs of a computer is very high as opposed to a low variable cost. Therefore, it is a wise capital investment only if it can be operated very near maximum capacity.

Evaluating Feasibility

After determining the economics in terms of net operating costs and start-up cost, a re-evaluation should be undertaken in terms of objectives, requirements, system design and equipment selection. If the re-evaluation reveals that the true cost reductions of the system designed to meet the requirements for obtaining the desired objectives are

very favorable as compared to the cost of the conversion start-up costs and the operating costs, a feasibility report should be presented to management that includes at a minimum:

1. Reasons for recommendation supported by facts.
2. The general purposes for which the computer will be used and the principal advantages.
3. Reasons for recommending the selected equipment.
4. The effects of the new system on the organizational structure and company procedures.
5. Personnel problems resulting from the changeover with details; i.e., loss or displacement.
6. Timetable of stages from planning to conversion.
In addition to timing, the timetable should show how the company may carry on its normal business during the period of changeover.¹
7. Return of investment computations.

If the feasibility report is approved, the controller will assist management in controlling the installation of the

¹ See Honeywell Electronic Data Processing, "Computer System Planning," Customer's Guide - Computer System Planning and Control which contains a detailed planning chart with a text to explain each period.

system. The mechanics to control are time, cost and quality of the system's design. Although, the controller is especially concerned with budgeting, proper accounting and exception reporting, control of time--planning scheduling, exception reporting and quality--planning, interdepartmental coordination, qualified personnel and sound system standards are essential tools for meeting target dates, a good system that is financially feasible and achieves the desired objectives. For an overview of computer system planning and control, see Illustration III in the Appendix.

CHAPTER IV

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

Introduction.--The purpose of this study was to discuss the basic problems involved in planning an EDP installation for the controller's division, the seven key steps in planning the computer installation, and related problems. Since the study is discussed on an introductory level, it may be read by an individual with no technical knowledge of electronic data processing to get an overview of the various phases of planning and installation, which is the least that is expected of accountants who may be assigned by management to direct an EDP planning committee for the installation of a management information system.

Procedures for collecting data were reviewing literature on management information systems, accounting and basic electronic data processing systems. Correspondence was used to secure material from management, associations, accounting associations and computer manufacturers.

Interviews with accountants and systems personnel were also a major source of information.

Historically, the controller has been responsible for introducing and operating large scale mechanized systems and the major use of these systems has been in his areas. Consequently, the controller is the usual and most logical person chosen to direct the EDP planning committee. However, the accountant may be found in three major roles--controller, auditor and consultant. The auditor, an external accountant, suggests and approves the audit techniques used to control and evaluate the system. Whereas, the consultant who is an external accountant providing management services examines and checks the plans before they are implemented.

The controller's EDP functions may include: (1) designing a system, (2) collecting and reviewing source data, (3) translating source data into technical language to be processed by the EDP unit, (4) solving accounting problems that may arise in the processing of source data, and (5) furnishing management with advice and recommendations based on the results of the financial statements produced.

The basic problem confronting the accountant is that of acquiring knowledge of principles of electronic data

processing because he cannot take time off from his regular duties to become acquainted with the computer and the electronic data processing system of bookkeeping before he is actually involved with an installation. This problem is being solved by accounting associations, electronic data processing organizations, and computer manufacturers and firms by publishing articles in literature read by accountants and non-credit courses using closed circuit television and lecturer's on the job and at other times which are convenient to the accountant.

The electronic data processing unit is composed of three distinct components: an input unit, the main computer, and an output unit. Media for input and output are punch cards, punched tapes, and magnetic tapes. Input devices include the card reader, punched paper tape reader, keyboard, et cetera. Printers, card punching machines, and paper tape machines are used to produce output. Storage forms of auxiliary equipment are the magnetic drum, magnetic tape drive and the magnetic disc. The main computer is a machine which has a tremendous capacity to store information in its memory banks for subsequent recall. In terms of speed, it will carry out programmed instructions and the results and beginning rates of 400 to 500 lines per minute. Once programmed,

it can relate financial information in an infinite number of ways.

The new bookkeeping system.--The basic accounting operations of the EDP bookkeeping system are the same as those under the manual system; however, they are executed within the EDP unit. The basic operations are: (1) transportation, (2) reference to files, (3) transcription, and (4) manipulation and storage. The designer of the EDP bookkeeping system may not be the accountant as is the case under the manual system. Other persons who may design the system include the statistician and the product control engineer. A preliminary analysis of the application of the system must be prepared before the installation which gives particular attention to non-routine and usual items. The double entry principal is utilized under the manual system. Whereas, the EDP system utilizes the poly-entry principle which is due to the transferring of data to some form of coded intermediary document such as a punch card before processing. This makes possible multiple classification and the documents may be used in any number of ways an infinite number of times to produce a variety of reports.

All processing subsequent to the input of data under the system such as sorting, calculating, posting, and recording

is carried on automatically within the machine. This feature, sequential processing, contributes to the lessening of the probability of making an error while producing at a minimum rate. Since the computer cannot form judgments, it performs consistently throughout the processing of large masses of information. Branching instructions are inserted in the programs in addition to planning for nonroutine and unusual items, provisions must be made for random inquiries and the interrogation of records because the records are invisible, the accountant needs the computer operator to secure the required information which may not be convenient because of other computer runs scheduled previously. However, this disadvantage is offset by the fact that the detailed coding of each unit of information at its source enables the computer to assemble and reassemble the units into the required pattern of the program; thereby, being able to produce numerous statistical reports--a feature which is termed "information retrieval."

The new book of accounts are stored on panel cards and magnetic tapes, and this presents several problems. The punch cards do not present a real problem because their contents may be printed on the top of each card. However, the magnetic tapes are invisible and an intermediary device

is needed to translate a hard copy format suitable for audit; and records can be erased without a trace. The seven key steps in planning computer installation in the proper sequence are as follows: (1) identify problems, (2) set objectives, (3) determine requirements, (4) design system, (5) select equipment, (6) determine economic value of system, and (7) evaluate feasibility.

Identify problems.--Management problems must be identified and analyzed before purchase of a computer, rather than starting with a solution, the computer, before the problem is thoroughly understood. Some common problems of the controller's division are analysis of data for management accounting reports and difficulty in meeting report deadlines because of too much input for speedy and accurate analysis.

Set objectives.--Subsequently, specific objectives should be clearly stated to avoid having the problem of an installation completely off target. For example, a system which does a tremendous job of controlling inventory, whereas, it should be used for billing. The requirements for the system should be determined in light of the particular problems of the company before selecting the equipment to achieve the objectives of the system--not vice versa. Many

objectives are not easy to evaluate in monetary terms; however, some value must be given to them in order to adequately determine the economics of the installation. Therefore, the controller must establish standards or estimate the worth of each function of the division.

At this stage, a CPA firm which offers EDP consultation services should be engaged because its staff is composed of specialists who have EDP training to supplement their accounting knowledge. They are in a position to assist the controller in the performance of feasibility studies, designing and producing computer programs; to give advice on computer selection and purchase, and help to resolve internal disagreement by acting as an impartial arbiter.

Determine requirements.--Requirements are determined by evaluating the present system in terms of needs for improvement or other alterations in order to achieve the desired objectives. The outlined requirements are prepared by the consultant and the EDP study committee reviews it with him, fills in details, and points out the aspects of the system. The controller, and representatives from finance, production and sales, should always be present at EDP study committee meetings. The minimum requirements of the system should be to provide permanent records of transactions and

financial statements with sufficient printout and records to provide an audit trail from the original source data to the financial statements--the balance sheet, operating statement, government reports required, including income tax returns, et cetera.

Design system.--The first and probably the most difficult problem of designing a system is defining the requirements of that system, which usually culminates in the desire for an over sophisticated system. That is, the controller would like a system which covers every possible convention. However, the minimum requirements mentioned in the preceding paragraph may serve as a guide. When designing systems, the components are designed in the following order: output, processing requirements for producing specific output and then input requirements. The plan of this design should include a general system design, detailed systems, write-up of check-out documentation and flow charts, and programming listings. Usually one and a half years is required for results from the larger practical systems and approximately six months for the smaller designs.

Auditing the EDP system.--Auditing the EDP system involves checking the total system by verifying the input documents and seeing that subsequent procedures are carried out

as planned.

To check the system, the auditor may use one of the following methods: (1) the black box approach, (2) job simulation, (3) audit in depth using statistical sampling system, (4) auditing the job file directly, (5) audit by exception. The black box approach entails feeding certain data to the systems and making a statistical analysis of the output resulting from the input. Having a computer run made of an intricate comprehensive sample job and comparing the results with that of the sample is referred to as job simulation. The audit in depth approach involves taking a small sample and checking it in detail through all of the routines of the systems. Whereas, auditing the job file is carried out with assistance of the programmer who explains flow charts, et cetera, in order for the auditor to get a bird's eye view of the procedure and to locate the control points in the system. In addition to the audit by "exceptions approach," a program should be written to pull out items which significantly vary from the standard for comparison. This is a most effective method and requires a minimum of time.

However, the auditor is faced with the problem of securing historical data because the various debits and credits are lost with the computation of the new balance as

a result of the destructive read-in feature of the computer. One solution is for historical data to be stored on tapes or discs in random order, adequately coded for effective recovery.

General accounting.--The initial applications are usually those which provide an immediate payoff in terms of dollar savings, and those which the fundamental system needs as a groundwork for gradual progression into a total management system. Specific accounting procedures adapted to the computer during the initial installation are problems which require: (1) voluminous calculations or printing, i.e., invoicing; (2) whose logic contains many special cases and exceptions, i.e., payroll; (3) whose answer must be precise--price; (4) job performed is processed on a cyclic pattern; and (5) data can be used in a variety of ways, i.e., purchase order, supply invoices, stock credits, et cetera.

Other problems faced by the auditor are those of information by random inquiries regarding specific transactions and preparing a report without notice. Since the records are on tape and require a computer run for translation into hard copy format which is not always convenient and economical, it is necessary to either schedule a special computer run at the

end of the day, or postpone the inquiry until the appropriate tape is run; or incorporate tape changing routine or special equipment for answering random inquiries.

Another problem is to maintain efficient reporting by limiting reports and minimizing the printout. This is necessary because printout is slower than computations which result in a bottleneck of information when voluminous data have to be printed out. Analyzing this data is time consuming; whereas, the time required for reporting to management has to be at a minimum in order for the information to be of value in decision making. In addition to minimizing the printout and limiting the number of reports, the work flow can be staggered to overcome problems created by interlocking reporting cycles. For example, four invoicing periods equal one statement period.

The generally accepted accounting procedure of closing books only after all transactions for the period are recorded in the accounts is considered a hindrance to the reporting process, in the case of minor and exceptional transactions, without justification and consistency of procedures with regard to accuracy when considering the accountant's use of broad estimates for cost expirations such as depreciation, and amortization. In addition, the loss of proven

accounting accuracy is a problem because records are kept invisibly and stored records and magnetic tapes may be replaced or erased without a trace. One safeguard against this is the duplication of records of transactions. Also to insure accuracy of input, the computer can be programmed to test the input with pre-determined limits. For example, if the limit was 38 hours, then 83 hours would be rejected. Also, proof totals are generated within the computer, i.e., gross pay equals the sum of departmental charges.

The problem of program is usually solved by selecting a computer language which is easily understood and easily mastered. The problem-oriented language of major concern to business data processing is COBOL, the Common Business Oriented Language which is near English in form. To prevent the problem of having several programs with separate sets of data, identical data which is quite cumbersome and results in wasted computer time. One set of data is referenced to the individual programs through a central index or master inventory of data files.

Personnel.--The controller's division is chosen to second staff the EDP center because it has personnel with more experience than any other group in getting and distributing information across departmental lines. The problems to

be encountered during this process are: (1) restructuring the controller's staff, (2) selecting members of the staff, (3) human relations difficulties, and (4) training the staff. To be effective, the new structure of the controller's division should be composed of four groups to be responsible for the following: (1) systems and procedures, (2) budget and planning, (3) reports, and (4) audit. Staff members should be selected on the general criteria of having the skill of logical thought, painstaking accuracy, neatness and diligence. The typical criteria for personnel are: (1) first choice, members of accounting, production, finance, sales, and personnel divisions of the company, (2) members with company experience of several years in departmental jobs, (3) those with the capacity to absorb new ideas and implement them.

The first and perhaps most important human relations problem is that of resistance to change which may be solved by: (1) eliminating the fear of unemployment by staff members who are worried because of the new EDP jobs, and by the fact that other departments are absorbing their old staff members as the conversion process proceeds gradually. More elaborate titles, promotions, and wage increases may be given to those who resist change because they fear loss of status.

The solution to the problem of making the organization knowledgeable of electronic data processing begins at the top with planning management which usually consists of the controller, members from executive offices, sales, distribution, and other affiliated departments who attend manufacturing seminars. They familiarize themselves with project control tools while formulating monitoring, evaluating and redesigning their own system design. Operating management, other than EDP attend seminars on EDP capabilities for operating management.

Since the controller must be concerned with upgrading his staff, the controller trainee is trained in specialized departments such as budgeting, corporate systems, accounting, auditing and data processing systems where he will be working directly with operating management planning, and implementing improvements in management information systems.

Systems personnel are trained in equipment characteristics and selected programming language; whereas, programmer training is just the opposite.

The computer is chosen on the basis of the definite job to be done as defined in the requirements for obtaining the desired objectives.

Some items that should be considered as points for

evaluating the equipment are the computer's advanced technological features, the adequacy of the main memory processing speed, the potentials for expanding equipment capability, the rating of cost-to-benefit ratio as compared with other manufacturers, et cetera.

Determining the economics of installation poses several problems. First, the cost of basic elements of the EDP center cannot be adequately determined because there is no common terminology accepted by accountants, data processors, and economists to describe the programming process, its products, and the personnel. The cost of these items must be expressed in terms of both accounting and economic "opportunity" costs. The lack of a common vocabulary extends to other problems, such as poor understanding of product quality, poor quality of cost data and non-quantitative areas of benefits.

However, a basis may be established to justify costs. Direct savings may be found in several areas including the cost of previous equipment taken out, reduction in space cost, overtime, et cetera. Non-quantative savings may result from speeding up the information flow to management and promoting more accurate information and having the ability to perform more complicated tasks.

The manufacturer's proposal provides a fairly sound basis for determining the cost of equipment. Present statistics indicate that computer purchases for accounting purposes range from less than \$10,000 to between \$50,000 and \$1,000,000. The monthly rental price median average is \$1,687 per month. The median average salaries for programmers is \$5,894 and for equipment operators is \$6,052.

The true cost of the computer is determined for using a checklist for an evaluation of specific features of the computer, which was mentioned previously, and the manufacturer's proposal which should contain detailed information on the alternative schemes for acquiring the computer (i.e., leasing, purchasing), maintenance, insurance, cost of educating staff, programming and systems aid, and other costs, such as air conditioning, structural alterations, and storage files.

Further analysis of cost must be in terms of initial costs, running costs, and fixed costs. Initial cost includes the cost of acquiring the computer, the systems survey, the consultant's fee, the cost of changeover period, the cost of editing and punching the basic files, structural alternations, education of staff and initial programming and installation. Running costs include personnel, EDP supplies, maintenance,

insurance, a share of the manufacturing overhead, et cetera. The fixed portion of running costs is very high as opposed to a low variable cost; therefore, it is wise to make the substantial investment in EDP equipment only if it can be operated at near full capacity.

The final step in planning the installation of an electronic data processing system in the controller's division is the preparation of a feasibility report for management. It should include the following items supplemented with statements of reasons supported by facts: (1) recommendations, (2) general purposes for which the computer is to be used, (3) equipment selected, (4) effect on organizational structure, procedures and personnel problems, (5) schedule of milestones leading up to and including the installation and methods for the carrying on of normal business during these periods and the changeover, and (6) the return on investment computation.

Conclusions

The accountant must become EDP oriented in order to maintain and/or increase his present status because the computer is used to perform previously exclusive accounting functions, such as to process tax records more efficiently

and with greater speed than the accountant under the manual system. As a result, management is demanding more specialized administrative services from the private accountant in the capacity of interpreting financial data and supply advice as to the causes and possible solutions of problems. In addition, he may be required to assist in the designing and installation of an electronic data processing system. The public accountant on the other hand is required to perform more management services such as identifying areas requiring investigation, interpretation of data, giving advice in various areas including evaluating and improving his client's accounting techniques. He may even be asked by management to serve as an EDP consultant whose services would include performing a feasibility study, designing an EDP system, and producing computer programs, and giving advice on computer selection and purchase. In addition, management may request him to audit the EDP system. To maintain his present position of prominence in the business advisory area, the accountant must become active in systems and prepare himself to serve in an EDP oriented capacity and enter EDP on one of three levels: (1) rendering the computer proposals, (2) performing computer feasibility studies, and (3) supervising computer installation jobs. He is in a

position to provide strong, effective leadership in the development of electronic data processing applications and services because of his familiarity with information resources of the company, experience in analytical work, and intimate knowledge of the expectations of corporate general management.

The organizational recognition of the controller comes in part from his performance as a systems designer. His authority to report and advise arises out of his position of independence which is essential for his objectivity while working with all departments. He is recognized as the interpreter of masses of details, the significance of which is determined by the information supplied by his superiors and colleagues.

Although the computer frees the accountant from the drudgery of monotonous or repetitious accounting operations, it presents astronomical problems for the controller. The more serious problems that occur after the installation can usually be traced back to the first three steps of planning the installation: (1) identifying problems, (2) setting objectives, and (3) determining requirements.

Another problem which is more significant than the most difficult problem of determining requirements, is that

of maintaining management involvement. Once management has appointed the controller to direct the EDP planning committee, the controller is left with the entire responsibility until after the installation. Therefore, the controller must stimulate management's interest in the project as well as that of the personnel on the lower echelons of the organization, because they will be the chief utilizers of information. Consequently, management may perceive the system as requiring simple planning and tend to pressure the controller for results because they underestimate the time and effort required for planning systems, designing and programming have no idea of the number of runs required, et cetera. Management involvement may be stimulated by periodic meetings to discuss the control and progress of the project.

Recommendations

The preceding study dealt with the planning stage of the installation of an electronic data processing system in the controller's division.

The introduction covered adequately the EDP functions of the accountant. In addition, the elements of electronic data processing, a general description of an electronic computer and the organizational components of the electronic

data processing unit were described in general. However, each of these topics are in areas where further study may be conducted. A beginning point would be: (1) to discuss in detail the book of accounts from the initial stage of the designing, (2) chart of accounts through the stages of EDP processing to storage in a central file and the retrieval, or (3) the EDP bookkeeping system as it relates to the manual system. The initial step of this study might be to trace the basic accounts, i.e., receivables, payables, from the designing stage of the installation through the implementation. The study might also include information regarding coding methods and systems, the phases of sequential processing as relates to the basic accounting operations using systems and programming symbols, et cetera.

A comparative study of the tripple roles that an accountant may assume are: (1) controller, (2) auditor, and (3) consultant. These areas would be most beneficial when choosing fields of specialization. In addition, a proposal for an accounting curriculum for a triple purpose preparatory program for general accounting, auditing, and administrative services which would provide an accountant with an adequate background in logical thinking, systems analysis,

and accounting theory--added advantages for both the public and private accountants.

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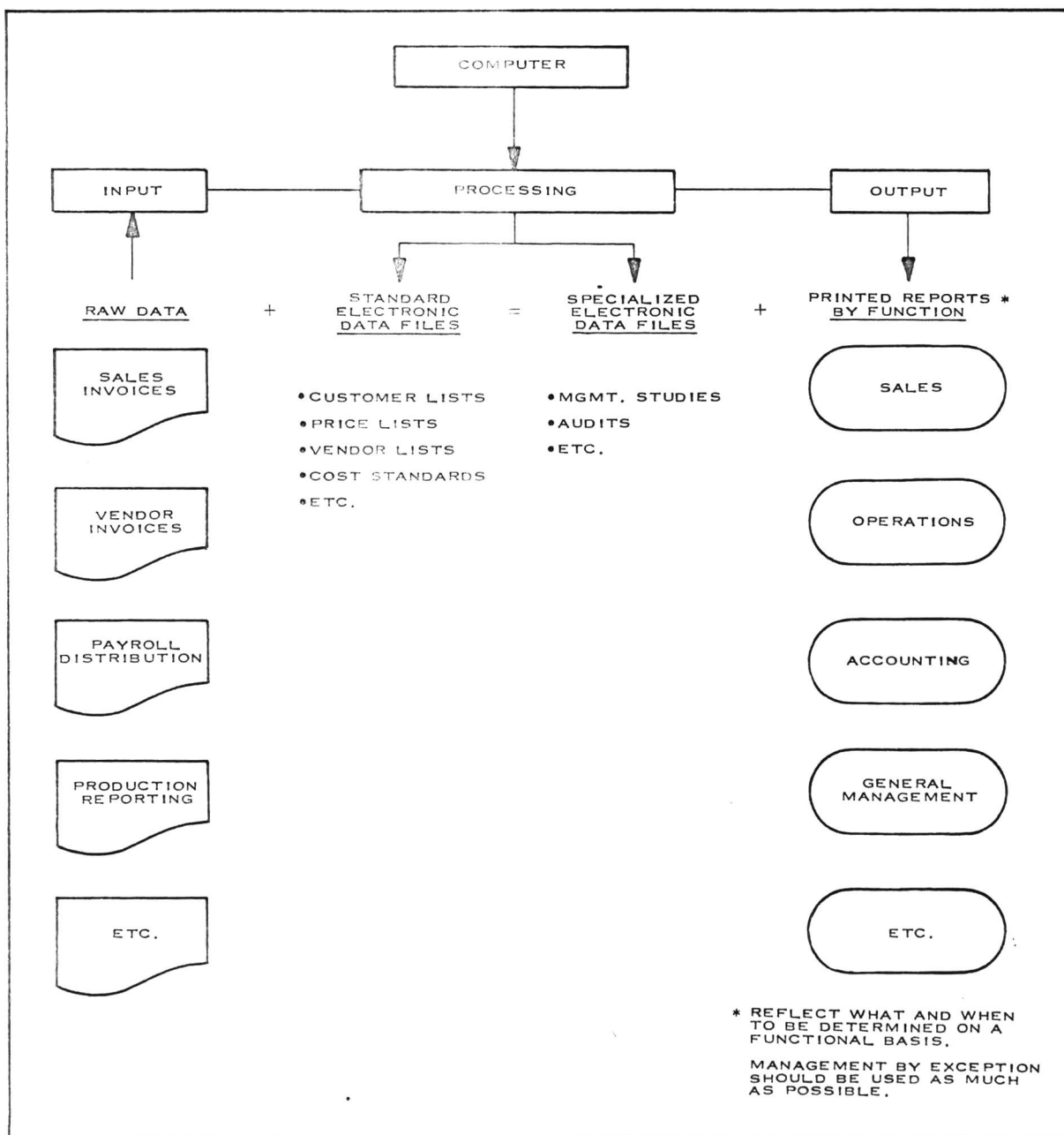
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A P P E N D I X

Illustration I

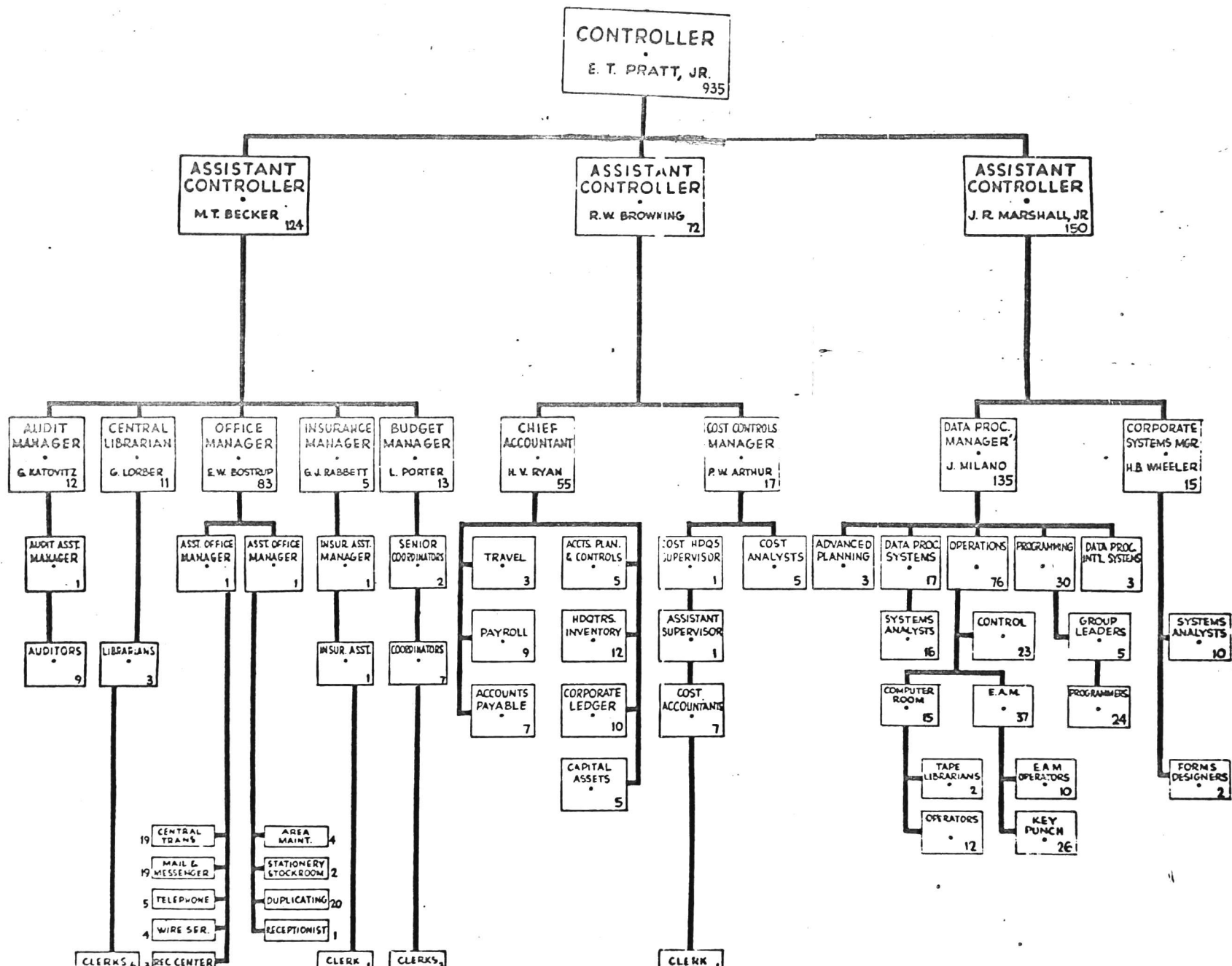
If a data processing unit is to serve its designated objectives, it must be integrated into the mainflow of the Company activities. It must not be an appendage to the Corporation.



As an integrated functional part of the company, the Data Processing organization is able to efficiently serve the total needs of the company. It is not organizational charts which make the organization, but the fact that management is confident of its goals and imparts this sense of direction to all members of the organization.

CONTROLLER'S DIVISION

Illustration II



112

COMPUTER SYSTEM PLANNING AND CONTROL



Planning
 Action
 Evaluation

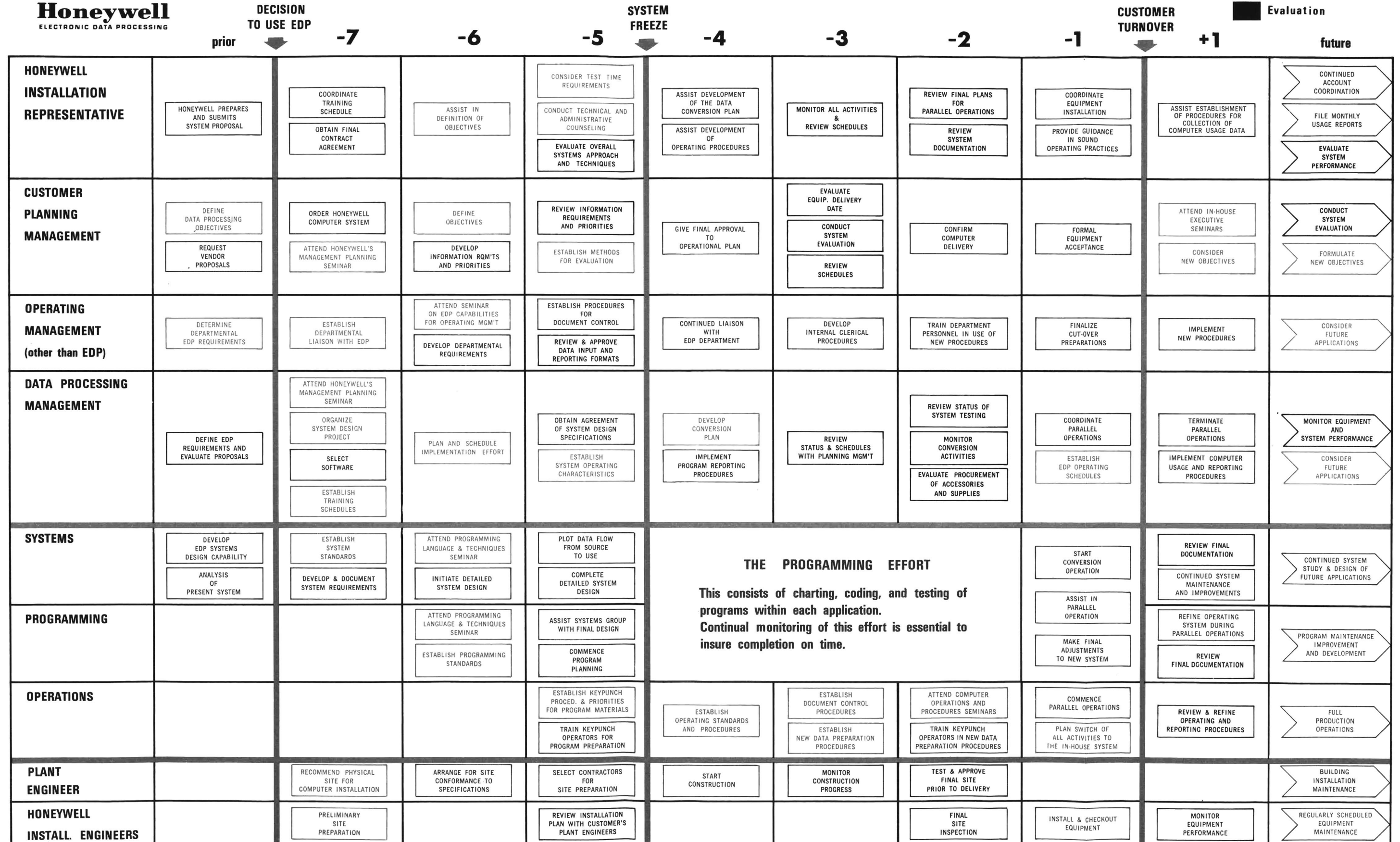
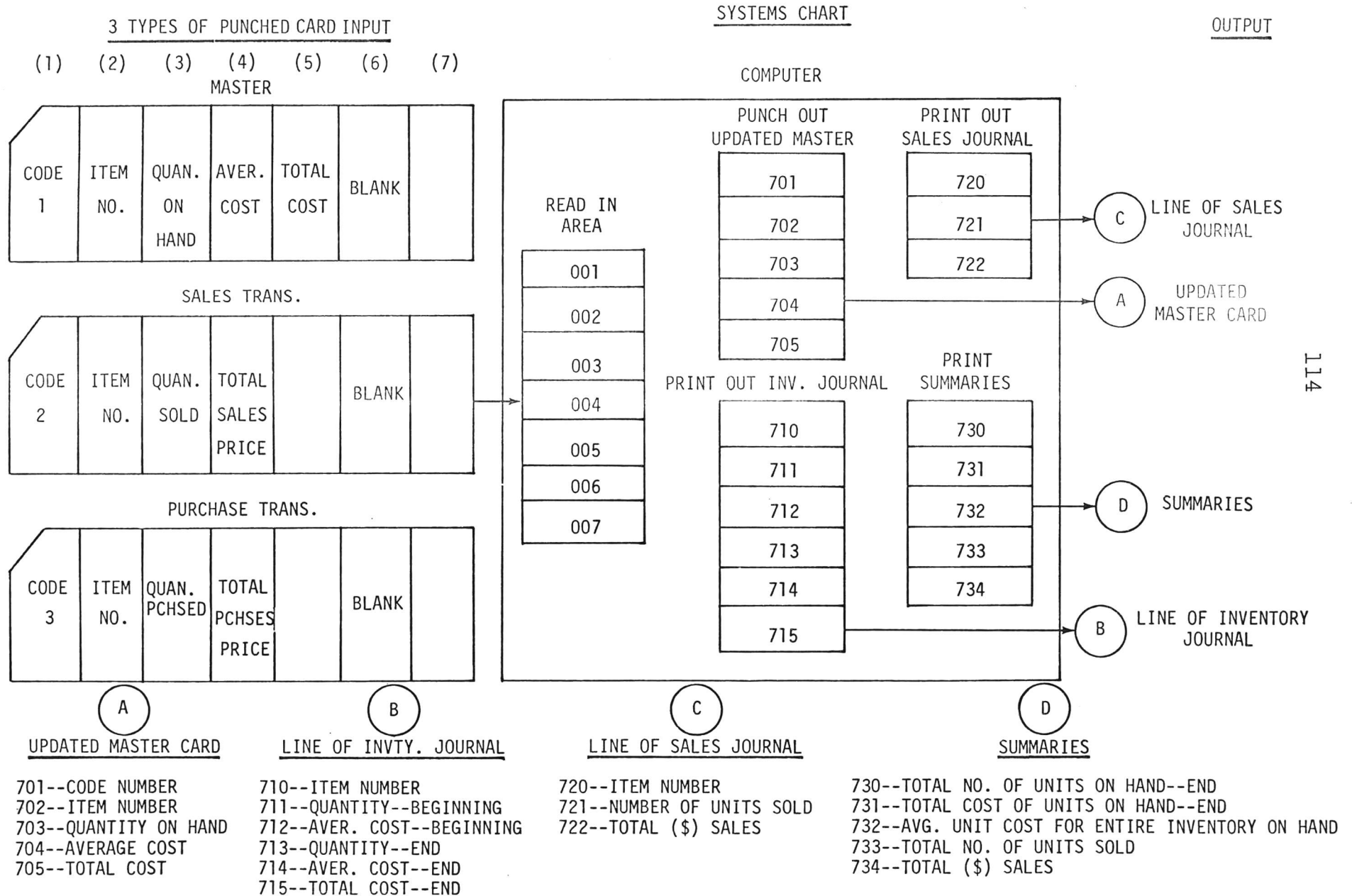


Illustration IV



Glossary¹

Access time (**). The time required to locate and read out of storage a specific piece of data--a character, a portion of record or an entire record.

Accumulator (**). The part of an arithmetic unit in a processing machine where the results of mathematical processes are developed.

Address (**). A location in memory or a component part of data processing equipment to which data are to be sent or from which data are to be received.

Arithmetic unit (**). That part of an automatic data processing machine in which the arithmetical and logical operations are performed.

Assembly printout (*). A listing of a program which shows (a) the program steps written by the programmer in the easier-to-use assembly language, and (b) the machine code version of the program into which the assembly language has been translated by the computer.

Assembly program (**). An electronic computer program used to translate a manually coded program of operating instructions into machine language and place the steps in the most efficient order.

Auditing "around" (*). The process of auditing where an EDP system is in use that does not make use of the computer itself. Transactions are traced from source to final reports, or from final reports to source, by using the computer

¹Sources of terms:

*Lynbrand, Ross Bros. and Montgomery. "Glossary, Accounting and the Computer". New York: American Institute of Certified Public Accountants, 1966.

**T. W. McRae, The Impact of the Computer on Accounting. New York: John Wiley and Sons, Inc., 1964.

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printouts as if they were records maintained by a manual system.

Auditing "through" (*). The process of auditing where an EDP system is in use by making use of the computer itself; the adequacy of computer programs is checked by means of test decks; programs developed under the supervision of the auditor can be used for selecting records for detailed analysis, while other programs can perform some of the analysis itself.

Automatic coding (**). A technique by which a computer is used to prepare its own operating instructions for the performance of standard routines through the use of the assembly program.

Authorization test (*). A form of programmed validation check. A transaction is checked against one or more tables of valid numbers to determine, say, whether the department specified in the transaction is authorized to initiate that kind of transaction.

Balance printout (*). A periodically prepared report showing the opening balance for each account in a file, a summary of all activity for the account during the period by type, and a closing balance for the account.

Batch (**). A number of records of documents grouped together for the purpose of processing as a single unit.

Batch controls (**). Techniques for insuring the completeness and the accuracy of the movement of batches of transactions; includes items counts, control totals, and hash totals.

Binary (***). A numbering system based on 2's rather than 10's which uses only the digits 0 and 1 when written.

Bit (**). The smallest element of binary machine language represented by a magnetized spot, a recording surface or a magnetized element of a storage device. Whether the bit represents a 0 or a 1 is determined by ascertaining whether the magnetism was created by a positive or negative electrical change.

Block (**). A group of words or records considered as a unit for control purposes in machine processing.

Block or flow diagram (**). A graphic representation of a sequence of operations of data processing machines using symbols to represent such steps as add, subtract, compare, transfer, read, write and clear.

Branching (**). A computer operation, similar to switching, where a selection is made between two or more possible courses of action depending upon some related fact or condition.

Built-in-check (**). A device that is included in data processing equipment by the manufacturer of various operations performed by machines.

Character mode test (*). A form of programmed validation check. It tests to see that all characters within a field are of the prescribed mode--that is, numeric, alphabetic, alphanumeric.

Cell (**). Storage location for one unit of data such as character.

Check (**). A means of verification. Includes built-in-checks and programmed and wire checks.

Clear (**). The replacing of information in a storage unit with zeros or blanks.

Cobol (*). The "Common Business Oriented Language" for programming business type problems. One of the languages whereby programs are written in a form resembling English, but with a rather rigid syntax and a vocabulary restricted and completely consistent in usage, and are translated by a computer program (a compiler) into the machine code required by the computer.

Coding sheet (*). The sheet on which the programmer writes the detailed machine instructions prior to conversion to machine language and entry into the computer; a part of program documentation.

Compare (**). To determine whether a particular quantity is higher, equal to, or lower than another quantity, or to

determine whether one piece of data is exactly like another.

Compiler (*). A program that prepares a machine-language program from a computer program written in another language, such as COBOL.

Compiler printout (*). A listing of a program which shows (a) the program steps written by the programmer in the easier-to-use compiler language (such as COBOL), and (b) the machine code into which the compiler language has been translated by the computer.

Completeness test (*). A form of programmed validation check that tests to see that all necessary fields of information are present in a transaction.

Computer (**). An electronic data processing machine and its auxiliary components capable of accepting information, applying prescribed processes, and supplying results in accordance with a program of internally stored instructions.

Computerized system (***). Is one in which most of the processing data is accomplished by a computer. Note that even the computer-based operation may require several hours of manual and EAM data preparation for every few minutes of computer processing. Nevertheless, a distinction is made between these two types of data processing through the use of words such as EAM vs. EDP, or nonautomated vs. automated systems.

Conditional transfer (*). A computer instruction which (a) analyzes the results of a previous comparison of two numbers, and (b) causes the computer either to continue with the next instruction in the original sequence, or (c) transfer control (branch) to another stated instruction, depending upon the results of the previous comparison. An example: continue with the next instruction in sequence if the two numbers are equal; branch to another instruction if they are unequal. This type of instruction gives the computer much of its power.

Console typewriter (*). A device provided with some computers by which the computer operator may enter instructions and data into the computer and by which the computer may type out preprogrammed messages.

Contents (**) . The data contained in a storage device.

Control group (*) . A group of clerks to which all data flowing to the computer is channeled and from which all computer reports are distributed. The main functions of the group are to detect and correct data movement errors and to correct errors detected by the programmed validation checks in the computer.

Control total (*) . A total of one information field for all of the records in a batch; an example would be the total dollars represented in a batch of department-stores sales checks.

Control unit (**) . An auxiliary component of a computer located behind the "main frame" and other component equipment such as tape units, printers and card readers for the purpose of controlling these components. The control unit receives instructions from the computer and controls the auxiliary components to see that these instructions are carried out. The translation to and from machine code or language is performed in the control units. Also, the part of a computer's main frame that directs the processing operations. Care must be taken when using this term to distinguish between these two meanings.

Copy (**) . To transfer data to a new location within a machine without destroying either the content or location of the data copied.

Counter (**) . A device for storing a number and allowing the number to be increased or decreased as directed by the instructions received. An adding wheel device.

Data Conversion controls (*) . Controls applied to the process of converting human language to machine language; the most pressing need for control occurs when the conversion is performed manually, e.g., by key punching data into punch card.

Data movement controls (*) . Controls applied in moving data from its source to its ultimate disposition; these include the use of batch totals and control groups.

Data processing center (**). A grouping of automatic data processing equipment and operating personnel in a separate area under the control of a single management group for the purpose of centralizing and controlling data processing operations.

Debugging (**). The process of isolating and correcting all malfunctions and/or mistakes in a piece of equipment or program or operations.

Dummy master record (*). A record inserted into a file for testing or auditing purposes; it would be handled like a regular record but would contain fictitious data.

Dummy transaction (*). A transaction injected into a data processing system for testing or auditing purposes; generally, dummy transactions would be posted to dummy master records, so as not to contaminate the regular records in the file.

Electronic accounting machines (EAM) (***). An electronic set of tabulators. The thing that distinguishes a computer from an accounting machine is that a program can be stored and operated by a computer. Accounting machines have pre-wired programs or plug-boards which control their operation.

Electronic data processing (EDP) (***). A name for a computer and its associated peripheral equipment, i.e., memory and processing units, printer, punched and magnetic tape devices, et cetera.

Error (**). The amount of loss of precision in a quantity. Errors occur in numerical data; mistakes occur in programs, coding or data transcription; and malfunctions occur in equipment, et cetera.

Error listing (*). A list of all of the types of errors which a program has been designed to detect, the probable cause of such errors, and the most likely necessary corrective action. This listing is prepared by the programmer when he writes the program.

Exception reports (*). Reports that do not list all of the records in a file, or all of the transactions in a batch, but only those that fall outside of a normal or expected range.

Father tape (*). See Grandfather-father-son.

Feedback (**). The process of returning portions of the results of an operation for the purpose of modifying later operations.

Field (**). A set of one or more characters making up a single unit of information. For example, the columns of a punched card set aside for the purpose of recording the data are called the data field.

Field validity tests (*). A form of programmed validation check that tests the value of a field against fixed or reasonable limits; for example, the day of the month should never exceed thirty-one.

File (*). An organized collection of related records, such as a customer file, a vendor file, or an employee file.

File protection (*). See Record security.

Flow chart (**). A graphic depiction of the logic of data processing system showing the routines required to solve a problem or arrive at a desired result. Less detailed than the block diagram, since individual machine operations are not shown.

Fortran language (***). "Formula translation" is a set of statements similar to algebraic expressions used by a programmer to describe the solution of a problem.

General purpose computer (**). A computer designed to operate on a program of instructions for the purpose of solving many types of data processing problems rather than being designed to fulfill a single function or type of function as a special purpose computer.

Grandfather-father-son (*). The principle of maintaining three generations of magnetic tape files. In an updating process, the input file to a computer run is called the "father" file, and the updated output file is called the "son" file. Similarly, the file that was used as input in the updating once removed is called the "grandfather" file.

Hardware (***). A computer and its related equipment such as paper and magnetic tape units, punched card readers, on-line printers and storage devices.

Hash total (*). A total of one or more information fields for all of the records in a batch used as a control mechanism. The total need have no intrinsic significance--e.g., the sum of employee numbers or social security numbers--since it merely checks for deviations from one operation to the next. Deviations in hash totals between one operation and the next might indicate loss of an item of data, perhaps loss of a punch card.

Input (***). Data introduced into an automatic data processing machine from an external source.

Instruction (**). A group of characters which define to an automatic data processing machine a specific operation; generally consists of an operation code and the addresses of the data to be operated upon.

Integrated data processing (**). A plan whereby all of the aspects of recording information for an activity are considered as an entity. Covers all recordable transactions from source to final reports and files.

Internal memory (**). Any one of the internal parts of an automatic data processing machine capable of retaining data.

Interpret (**). The translation of coded characters into standard letters, numbers and symbols.

Item count (*). The count of the number of items or transactions in a batch; if there can be a variable number of documents per transaction, the count must specify whether it applies to the transaction or to the documents.

Keypunch (*). The act of converting human language to machine language by means of a manual operation; most generally, the machine language is recorded in a punched card or punched paper tape.

Label, internal (*). A magnetic record at the beginning and/or end of a magnetic tape file identifying the reel.

Ledger-type printout (*). A written record that shows both a line-by-line listing of transactions affecting an account and the resultant account balance.

Library (**). An ordered set or collection of standard data processing routines from which sequences of instructions can be drawn in the formulation of a program.

Library, program and files (*). A repository for storing magnetic tapes, punched cards, or punched paper tape containing the computer programs for the installation, as well as the master files and transaction files.

Location (***). An address in memory.

Log (*). A listing of all transactions of a specific type.

Loop (***). The repetitious execution of a series of instructions caused by having the last instruction in the series return the machine to the first instruction in the same series.

Machine code (*). The computer program in the form that it is used by the machine.

Machine flow chart (*). A graphic representation of the flow of information between computer runs, for a system or application. (See program flow chart.)

Machine language records (*). File records, transaction records, and report records in a form that can be read by the machine; an example would be transaction records stored on magnetic tape.

Machine logic (***). The capability of an automatic data processing machine to make decisions based upon the results of tests performed.

Magnetic core (***). The small doughnut-shaped piece of ferrous metal used in constructing a core memory unit.

Magnetic drum (***). The rotating portion of a drum memory.

Magnetic tape (***). An external storage device in the form of a ferrous oxide coating on a reel of metallic or plastic

tape upon which bits may be recorded magnetically as a means of retaining data.

Magnetic tape system (*). An EDP system which uses magnetic tapes as the primary form of file and transaction record storage.

Message (*). A group of characters transmitted as a unit; transactions are sometimes called "input messages" and report records are sometimes called "output messages."

Narrative (*). The written description of the flow of information in the system.

Noncomputerized system. A system which includes any combination of the following:

1. Entirely manual calculations
2. Use of desk calculators
3. Use of larger EAM machines.

Operand (**). A piece of data upon which an operation is performed.

Operator, computer (*). The person who manipulates the computer controls, places information media into the input devices, removes the output and performs other related functions.

Operation (**). A single action of an automatic data processing machine.

Output (**). An item omitted from an automatic data processing machine.

Policy test (*). A form of programmed validation check that tests policy relationships between fields within a record; an example would be checking the amount of a new mortgage loan against the valuation of the property.

Program (*). The complete sequence of machine instructions and routines necessary to solve a problem or process data.

Program (verb, **). To plan the solution of a problem or the method of attaining a result and translate the plan into instructions.

Program change control (*). A standardized procedure for reviewing and approving all proposed program changes and for recording the status of the program both before and after the change, the date of the change and the date it became effective in the processing, the name of the person making the change, and the procedure for physically changing the program library tape.

Program flow chart, detailed (*). A graphic representation of the computer program, using a standard set of block symbols to represent the computer operations. Concise symbolic notation is used to represent the information and describe the input, output, arithmetic, and logical operations involved.

Program loading routine (*). A routine which, once it is itself in the computer's memory, is able to bring the remainder of the program into the computer's memory from magnetic tape or punched cards.

Program logic chart (*). A graphic representation of the major steps in a computer program, showing how the problem is attacked logically. Notation is in English and is not related to the operations and characteristics of any one type machine.

Programmer (*). A person who prepares the problem-solving procedures and flow charts for solving a problem on a computer, and who may also write and debug the routines.

Quiet errors (*). Certain errors that might go unobserved or be quietly accommodated under the more flexible and tolerant manual systems, but which are immediately brought to light under the rigid discipline of computer programs, which require an internal consistency manual systems do not.

Random access memory (*). A storage technique in which the time required to obtain information is independent of the location of the information most recently obtained.

Read (***). The process of introducing data into a component or part of an automatic data processing machine.

Record (*). A group of related facts or fields of information treated as a unit; a record usually applies to an event

(a transaction) or to a thing (such as a specific customer or a specific product).

Record layout (*). A listing of all of the fields of information in a record and the manner in which they are arranged in the record.

Record security (*). The ability to reconstruct records in case they are found to be damaged or in error.

Redundancy (*). The fraction of the gross information content of a message that can be eliminated without the loss of essential information.

Run (*). A self-contained computer operation--e.g., preparation of a payroll--which requires no (or very little) intervention by the computer operator into the operation of the computer itself.

Register (***). A device capable of both storage and arithmetic processes within an automatic data processing machine.

Routine (***). A set of operating instructions in a sequence necessary to perform a function such as an update routine or an end-of-file routine.

Self-checking number (*). A number, the last digit of which is a "suffix digit," not a part of the quantity represented by the preceding digits but having a consistent relation to the preceding digits or quantity.

Service agency (***). The general category of organizations which perform one or more aspects of a data processing operation for a prearranged fee or time charge. The service may include the design of a complete data processing system, coding a program or the periodic operation of programs on their computer. A major portion of these agencies has a staff of system analysts, programmers, managers, et cetera. These agencies are often affiliated with a computer manufacturer. Another category of agencies has developed through banks.

Shift (***). The movement of a character or group of characters to the left or right or a given point of reference in a memory or arithmetic unit. Also a portion of a 24-hour period during which ADP equipment is operated.

Software (***). Anything related to a computer that is not hardware (such as procedural documents, operating instructions, training and maintenance manuals), although it is more commonly used to mean computer programs.

"Son" tape (*). See Grandfather-father-son.

Storage (***). Portions of automatic data processing equipment capable of retaining data for later use. (See internal memory.)

Store (***). The operation of placing data in storage.

Suspense file, rejected transactions (*). A file for rejected transactions for which corrective entries to the program have not been received.

Symbolic coding (***). A method of programming in which the machine instructions are written by the programmer in a type of symbolic shorthand. A symbolic coded program must then be translated into machine code.

Symbolic programming language (*). The use of mnemonic symbols to represent computer operation codes, memory addresses, and data, so as to make programming easier and to reduce errors.

System (***). The interaction of one or more programs and human actions which perform a function. Example: A "payroll system" might consist of the manual preparation of weekly employee data, keypunching input cards, the operation of a program on a computer and the utilization of the computer outputs such as paychecks. The payroll program is one component of this system.

Systems flow chart (*). See machine flow chart.

Systems analyst (*). The person who performs the analysis of a business activity to determine precisely what must be accomplished, and who lays out the overall design of the new system.

Test deck (*). A set of data developed specifically to test the adequacy of a computer program or group of programs, either for debugging the program or for testing the internal control features incorporated in the program.

Transaction (*). A record of occurrence of a new event; an input message for a data processing system.

Transaction recorder (*). A device for recording a transaction in machine language at, or close to, the point at which the transaction takes place.

Transaction reference number (*). A number included as part of a transaction record to provide a reference for locating the original source document of the transaction; such a number might consist of a date and a batch number.

Update (*). To bring a master data file up to date, by posting recent transactions to it, adding new records, and deleting obsolete records.

Validation checks (*). Tests that can be built into computer programs to check the accuracy, completeness, and propriety of input transactions.

Word (***). A unit of data. A set of characters which may be of any length and which occupies one storage location. A word is usually treated as a unit by a data processing machine. Quantities, dollar amounts and names are all examples of words.

Write (***). The process of transferring data from a component of a data processing machine to another component or to another medium such as a printed report or magnetic tape.

Write-protection (*). A device or method which prevents the accidental erasure of data on a reel of magnetic tape.